SEASONAL TRAVEL DEMAND AND PEAK LOAD PRICING ON THE AUSTRALIA-U.S.A. AIR ROUTE.

by

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This dissertation represents my own original work and contains no material which has already been published or otherwise used by me, and to the best of my knowledge it contains no copy or paraphrase of material previously written by another person or authority, except where due acknowledgement is made.

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INTRODUCTION

Since the early 1970's international travel and tourism have become important issues to many governments and of course the airline operators who have had to contend with rapidly rising costs of operations and capital. To some extent this problem has been alleviated through rapid technological advances made in the aviation industry. At the same time the airline operators have become aware of the leisure travel market which throughout the mid to late 1970's has provided the airlines with a boom period. This boom is slowly tapering off at a time when major carriers have just completed a re-equipment phase aimed at a growing market; pricing strategies have become an increasingly important tool for the operator to increase utilisation of their capacity.

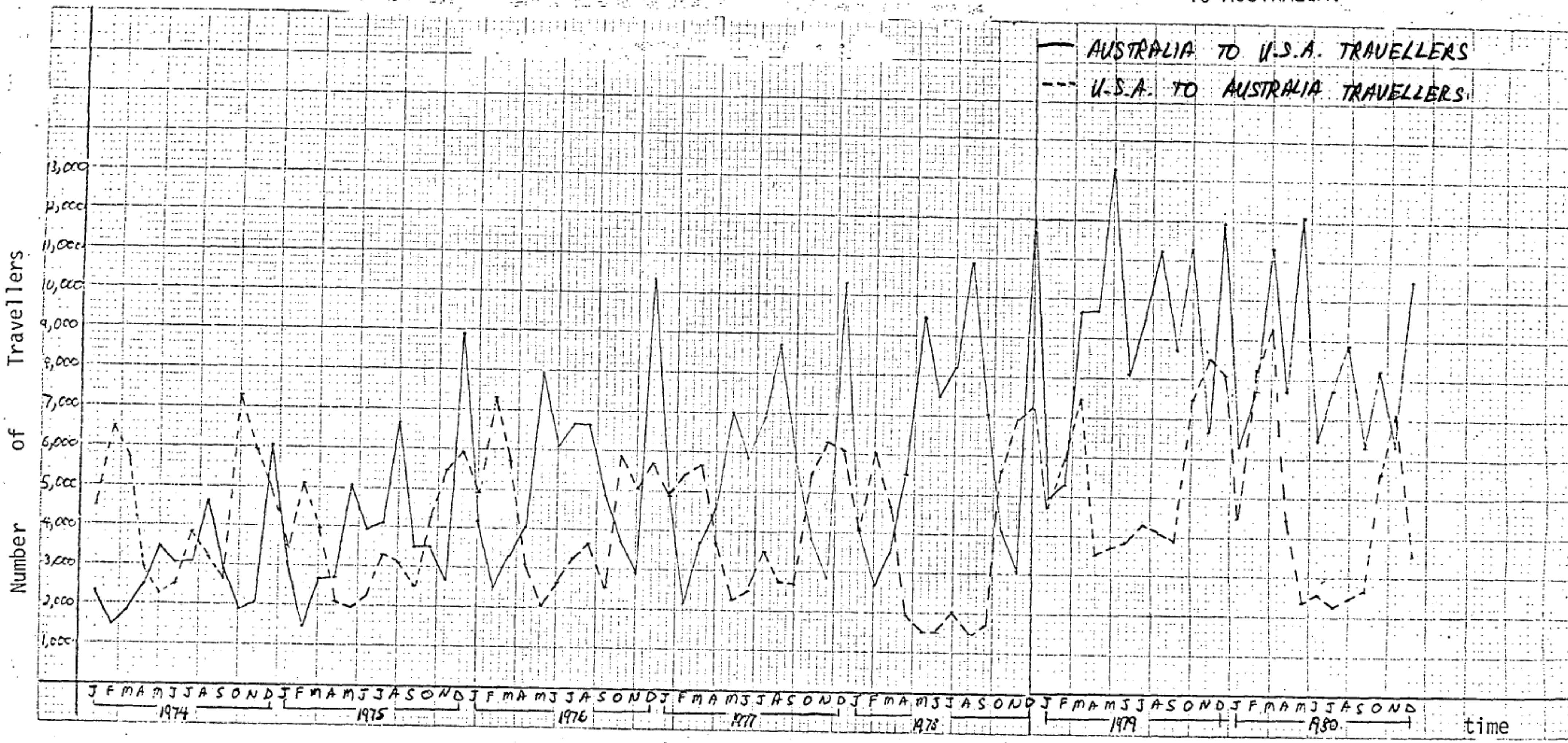
Many researchers have used econometric techniques for estimating airline demand functions, from these studies aggregate fare elasticities, different fare class elasticities, income elasticities and other service elasticities have been estimated. Each of these studies has shown the importance of fare and income elasticities in the leisure travel market. These basic estimates have helped to form some useful pricing policies. Recently operators and policy makers have noted the variability of demand for travel over time; as supply is fixed in the short run, operators have experienced periods of excess supply and periods of excess demand. To combat this variability of demand over time, operators have introduced seasonal pricing. As this is a recent innovation, no research work has been done on estimating the cross relationship between travel seasons. This study attempts to estimate the cross relationship between travel seasons on the Australia-U.S.A.-Pacific air route.

Seasonal and directional imbalances were cited by the Review Committee on Australian international civil aviation policy as being one of the major problems facing airline operators operating to and from Australia. Seasonal demand imbalance refers to the fact that travellers have preferred months of travel, which tends to lead to periods of high demand being concentrated into a few months of the year. Directional demand imbalance refers to the growing disparity between arrivals and departures into Australia. Figure 1 highlights both seasonal and directional demand imbalances. For Australian leisure travellers travelling to the United States the peak months are May, June, August and December.[1] The off-peak months are February, March, October and November and the official shoulder months are January, April, July and September. While for travel from the U.S.A., the peak months are August, September, October and January; the shoulder months are February, July, November and December and the off-peak months are March, April, May and June. Seasonal demand imbalance focuses on travel in one direction, while the directional imbalance focuses attention on travel in both directions. For instance, a good example of the directional imbalance problem is that the peak travel months for Australians going to the U.S.A. are May and June, which are the off-peak travel months for Americans visiting Australia. Both these imbalances create problems of which capacity utilisation is a major one.

In 1979 the operators on the Australia-U.S.A. route made a conscious attempt to smooth out demand. They introduced seasonal price variations on the advanced purchase fare (APEF), the Group inclusive air fare (G.I.T.) and the Budget fare. The effects of these fares can be seen in Figure I. for true origin destination leisure travellers on the route for 1979 to 1980. The results are still unclear, but there

1. Source, Department of Transport Australia, Canberra.

FIGURE 1. LEISURE TRAVELLERS, AUSTRALIAN TRAVELLERS TO THE U.S.A. AND AMERICAN TRAVELLERS TO AUSTRALIA.



SOURCE: Overseas Arrivals and Departures, A.B.S. Catalogue No. 3401.0

appears to be a reduction in travel in the peak (Australia to U.S.), while off peak travel seems to be increasing in both travel directions.

This study estimates the cross relationship between travel seasons using the ordinary least square technique. The results from the model will be used to determine the optimum level of fares for each season to ensure efficient utilisation of existing capacity.

CHAPTER 1.

THE INTERNATIONAL AIRLINE INDUSTRY

A. OPERATIONAL FRAMEWORK

Commercial aviation grew strongly after World War II, with two nations being primarily responsible for setting up the operational framework of the industry; they were the United States and the United Kingdom. These two nations had opposing views, the United States favoured an open skies policy while the United Kingdom favoured regulation in the form of strict capacity limits. The 1946 Bermuda agreement between the two nations saw a compromise of opposing views, but more importantly set up a framework for an exchange of landing and traffic rights, the basis of a bilateral agreement.

Prior to the 1946 Bermuda agreement, two basic freedoms for international airline operators were drawn up at the 1944 Chicago Convention. These freedoms were:[1]

FIRST FREEDOM:	the privilege to fly across a contracting party's territory without landing, and
SECOND FREEDOM:	the privilege to land for non-traffic purposes (i.e. refuelling and maintenance).

A further three freedoms were drawn up at the 1946 Bermuda agreement:[2]

THIRD FREEDOM:	carrier has the privilege to put down passengers, mail and cargo originating from its own territory,
FOURTH FREEDOM:	a carrier of a contracting party has the privilege of picking up passengers, mail and cargo destined for its home country.

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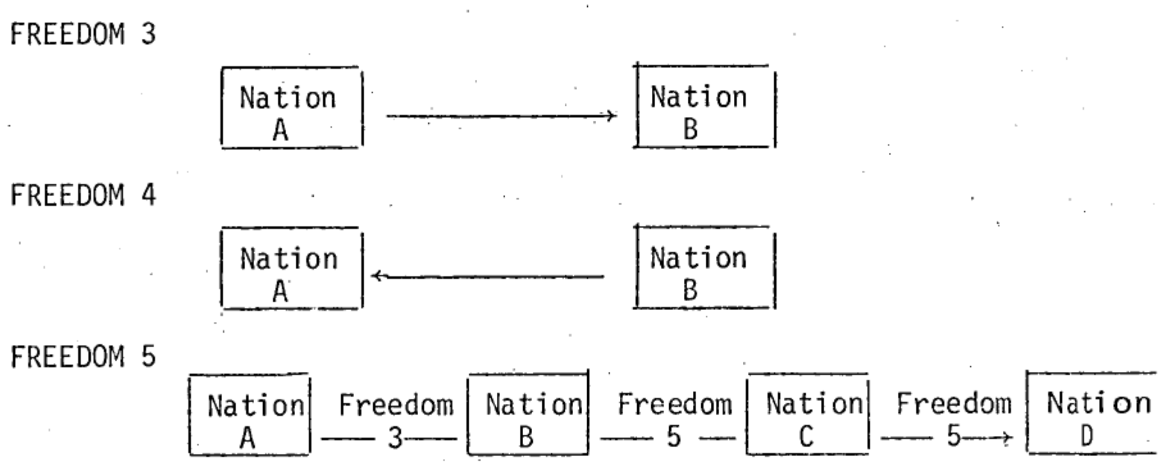
1. Report of Review Committee, *Review of Australian International Civil Aviation Policy*, 2 Vols., (Canberra, A.G.P.S., 1978) Vol. 1, p.5.
2. *Ibid.*

FIFTH FREEDOM: a carrier has the privilege to take on passengers, mail and cargo destined for the territory of any other contracting state. It also has the privilege to put down passengers, mail and cargo originating from any of its other contracting states.

The intent of the third, fourth and fifth freedoms may be made clearer by the following diagram.

DIAGRAM I.

A diagramatic representation of the third, fourth and fifth freedoms, based on airline domiciled in Nation A.



Source: Report of Review Committee, *Australia's International Civil Aviation Policy,* (Canberra, A.G.P.S., 1978), Vol. I, P-6.

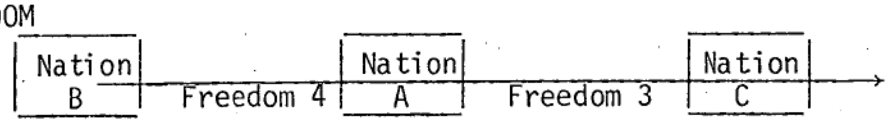
Thus on the Australia-U.S.A. air route, the bilateral agreement allows for the Australian designated carrier (Qantas) to take passengers from Australia to the U.S. (third freedom). The fourth freedom gives Qantas the right to pick up Australia bound passengers from the U.S. The fifth freedom allows Qantas to set down traffic from Australia at any intervening port of call and then to carry the remaining traffic through to the U.S.

To these basic freedoms there should be added the so-called sixth freedom. This freedom refers to the situation where the designated airline of one state party to an agreement carried traffic between the grantor state's territory and that of a third state, with a stop in the airline's home territory.[3] This sixth freedom is a mixture of the third and fourth freedoms, this can be seen in diagram 2.

DIAGRAM 2.

A diagramatic representation of the "sixth freedom", based on airline domiciled in Nation A.

SIXTH FREEDOM



Source: Report of Review Committee, *Australia's International Civil Aviation Policy* (Canberra, A.G.P.S., 1978), Vol.1, P-6.

As Australia is usually a terminal point for air services, transit traffic is small and sixth freedoming by other carriers may only be negligible. An example of sixth freedoming on the Australia-U.S.A. Pacific route is as practiced by Air New Zealand. Travellers bound for the U.S. are picked up by Air New Zealand, flown to Auckland and then to the U.S.

Most countries exchange carrier operating rights through bilateral negotiations. Attempts to use multilateral agreements failed because it became impossible to reconcile the vast differences in policies between nations. This contributed to the International Air

3. *Ibid.*, p.5.

Transport Association's (I.A.T.A.) failure to carry out its main role, that is as a fare setting body.[4] At these fare setting conferences I.A.T.A. had to reconcile the very different positions among carriers: each carrier had its own cost function on which it wanted to base its fare, and secondly, the motivation behind most of the carriers was the achievement of government set objectives.[5]

Thus the bilateral agreements dictate the operational environment between the two contracting states. The most important matters covered in a bilateral are the fare to be charged and the operating capacity and its adjustment mechanism.[6]

B. CAPACITY AND TARIFFS

An air services agreement between Australia and any other contracting state would eventuate if there is sufficient true origin and destination traffic on the proposed route.[7] The volume of true origin-destination traffic would also determine the level of capacity offered. Once capacity has been determined, flight frequency is also determined.

The Australian policy on capacity has been to allow the predetermined capacity level to be modestly in excess of the anticipated demand for travel.[8] If the underutilised capacity is minimal, the carrier's unit cost of production would fall and it is part of the Australian policy to attempt to ensure low cost travel to Australian consumers.

In most bilateral negotiations, attempts are made to split the

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4. M.R. Straszheim, *"The International Airline Industry"* (Washington D.C., The Brookings Institution, 1969), p. 33.

5. *Ibid.*, p.

6. Report of Review Committee, *Australia's International Civil Aviation Policy* (Canberra, A.G.P.S., 1978), p. 9.

7. *Ibid.*, p. 8.

8. *Ibid.*, p. 18.

T.O.D. traffic between the two carriers. Thus the capacity level offered by each carrier would approximately be enough to satisfy half of the market demands. At all times traffic levels are monitored. In most agreements there is a trigger mechanism which allows upward adjustments of capacity once a certain level of traffic has been achieved. On the Australia-U.S. route there is more flexibility with regards to capacity adjustments: capacity can be adjusted upwards or downwards with only the approval of the originating country's regulatory body being necessary. After a period of six months the effects of this new level of capacity is reviewed.[9]

The level of fares offered on the routes will affect capacity utilisation on the route. Most fares have to be agreed upon by both contracting states, along with any subsequent fare changes. However, on the Pacific route in 1978 an amendment was made regarding fares, giving either party the right to introduce new fares without the other party's approval.[10] The effects of the new fares are subject to review after six months.

Schedule operators have maintained that at any point in time capacity must be greater than demand. The reasons are:[11]

(a) maintenance of departure time flexibility,

(b) multi-stop services face varying traffic direction, and

(c) variations in time and direction are inevitable concomittants of demand.

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9. Unfortunately, the libraries do not hold the original 1946 bilateral agreement between Australia and the U.S. The source of this information was Prof. J.H.E. Taplin, and was verified by the D.O.T., Canberra.

10. Australian Treaty Series, *Amendment to the Air Services Agreement with the United States* (Canberra, A.G.P.S., 1980), No. 2.

11. Report of Review Committee, *Review of Australia's International Civil Aviation Policy*, 2 Vols. (Canberra, A.G.P.S., 1978), Vol. 2, p. 420.

Another factor that has affected capacity has been the rapid technological advances made within the aviation industry, particularly the introduction of wide-bodied jets. The use of wide-bodied jets has affected scheduling flexibility, firstly as capacity has become more concentrated, the number of planes required to service a route (assuming no increase in demand) will be reduced which reduces flight frequency. Secondly, operators are reluctant to reduce frequencies as it may reduce their market shares. This suggests the operators believe the frequency elasticity to be at least one. However research has shown frequency elasticity to be below one. Ippolito estimated a frequency elasticity for some U.S. domestic routes to be 0.864.[12] If flight frequency were reduced by 1% this would lead to a reduction of patronage by 0.864%. Thus a reduction in the level of frequencies offered may not lead to a more than proportionate decrease in patronage.

C. COSTS

To determine the appropriate fare structure, the operator must have some understanding of the structure of costs. Financially, an airline's cost of production is influenced by:[13]

(a) distance,

(b) aircraft size and speed,

(c) utilisation, and

(d) tangible aspects of service quality.

The items listed above affect mainly the airline operating costs.

The route network of an airline will determine its cost structure. Different aircraft are designed for different stage lengths and by carefully matching the equipment with the route network the operator may

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12. A.I. Ippolito, "Estimation of airline demand with quality of service variables", *J.T.E.P.*, Jan. 1981, p.13.

13. G.N. Douglas and J.C. Miller, *Economic Regulation of Domestic Air Transport: Theory and Policy*, p. 6.

reduce his unit cost of production. The average cost of any type of aircraft is found to decrease with distance up to a certain point. The decreasing cost per passenger is due to the fact that a disproportionately large share of fuel is consumed during the take off.[14] Further, the crew and aircraft time in the take off and landing processes are a fixed cost which can be spread over more miles as the stage length increases.[15] There may also be some economies of scale associated with aircraft size: equipment and crew costs do not increase proportionately with increased capacity.[16]

Three other major categories of costs are ownership cost of capital (principally aircraft), passenger and flight traffic costs and overhead expenses. The largest share of the cost of operating a scheduled air transport system is the cost of generating capacity, specifically operating costs and ownership cost of capital.[17]

The regulatory environment is of particular interest: if the airlines were allowed to compete freely, management would be forced to become cost-conscious and only efficient carriers would survive.[18] At present the international airline industry is regulated, probably allowing inefficient carriers to continue to exist.

As noted above, by matching the equipment to the route characteristics, airlines can achieve significant cost savings. Per passenger cost can be lowered further by increasing the load factor, resulting in operating costs and fixed costs being spread over more passengers. In

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14. M.R. Straszheim, *The International Airline Industry,* 1969, p. 85.

15. *Ibid.*

16. *Domestic Air Transport Policy Review,* 2 Vols. (Canberra, A.G.P.S., 1979), Vol. 2, p. 12.

17. G.N. Douglas and J.C. Miller, *Economic Regulation of Domestic Air Transport: Theory and Practice,* p. 7.

18. *Domestic Air Transport Policy Review,* 1978, Vol.2, p. 13.

the short run capacity is fixed and cannot be stored while demand is variable over time. If one fare level is used this would create an excess of demand and supply at various times of the year due to the seasonality of demand. In the peak season (usually the summer months) there may be an excess of demand over supply in which case each seat acquires a rental value and the fare should reflect this. In the off-peak season (usually the winter months) the reverse occurs and there is no rental value to charge the users. Intuitively, fares should be varied between season; this may discourage some peak travellers while encouraging a greater use of the capacity available in the off-peak. The general result is a smoothing of the peaks and troughs, leading to a higher overall load factor.

CHAPTER 2.

EFFICIENCY AND PEAK LOAD PRICING

In the previous chapter it was shown that the demand for travel is subject to seasonal movements. Variation in travel demand occurs throughout the year, the day of the week and the time of the day; thus at certain periods the resources available are under utilised; this imposes additional cost to both the users of the facility and the producers. Peak load pricing could provide a solution that would improve capacity utilisation, while making travel available to a greater proportion of the public.

Peak load pricing becomes feasible when demand varies with time and a common supply system is used in the peak and off-peak periods.[1] The solution sought is one which reflects the cost at various times and simultaneously discourages consumers from overloading the system when it is used most intensively (i.e. in the peak periods).[2] The effect of peak load pricing is not necessarily to eliminate growth in the peak period, but to set prices which reflect costs and provide consumers with the correct signals to enable them to take into account the consequences of their increased demand on the system.[3]

The role of pricing is twofold, firstly: it has a role of directly allocating resources efficiently. Secondly, it provides a signal to invest.[4]

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1. C.M. Price, *Welfare Economics in theory and practice* (Macmillan, London, 1977), p. 139.
2. *Ibid.*, p. 139.
3. R. Turvey and D. Anderson, *Electricity Economics* (John Hopkins, University Press, Baltimore, 1977), p. 71.
4. J.J. Warford, *Public Policy Towards General Aviation* (Washington D.C., Brookings Institution, 1971), p. 31.

A. PEAK LOAD PRICING*

The transport industry is typified by a demand that tends to vary with time and a common supply system that is fixed in the short to medium term. In the airline industry, capacity is fixed in the short run through bilateral agreements and fares are also fixed in the same manner. However, the Australian government does encourage the use and development of promotional fares. Thus there is some scope for flexibility in this area. Adopting an incorrect price set in this situation could lead to poor aircraft utilisation and wrong investment decisions.

Assuming the authorities are concerned with maximising social welfare, the following pricing strategy should be adopted to equate price to marginal cost. For ease of exposition it is assumed that first best conditions are prevalent. It is also assumed that there are only two demand periods in a year, the peak period lasting two-thirds of the year and the off-peak period lasting the remaining third of the year. Further, the two demand periods are independent of each other.

The basic rule for peak load pricing is to set the price in each demand period to its corresponding short run marginal cost with the investment decision being based on the long run marginal cost. The short run marginal cost consists of the operating cost, while the long run marginal cost consists of both the operating cost and the capacity cost. Following the general rule the off peak price would generally be below the long run marginal cost while the peak price would be above the long run marginal cost. This effect can be seen in diagram II.1 where the capacity costs are β per unit per period, the operating costs are b per unit per period and the plant is assumed to be completely divisible.

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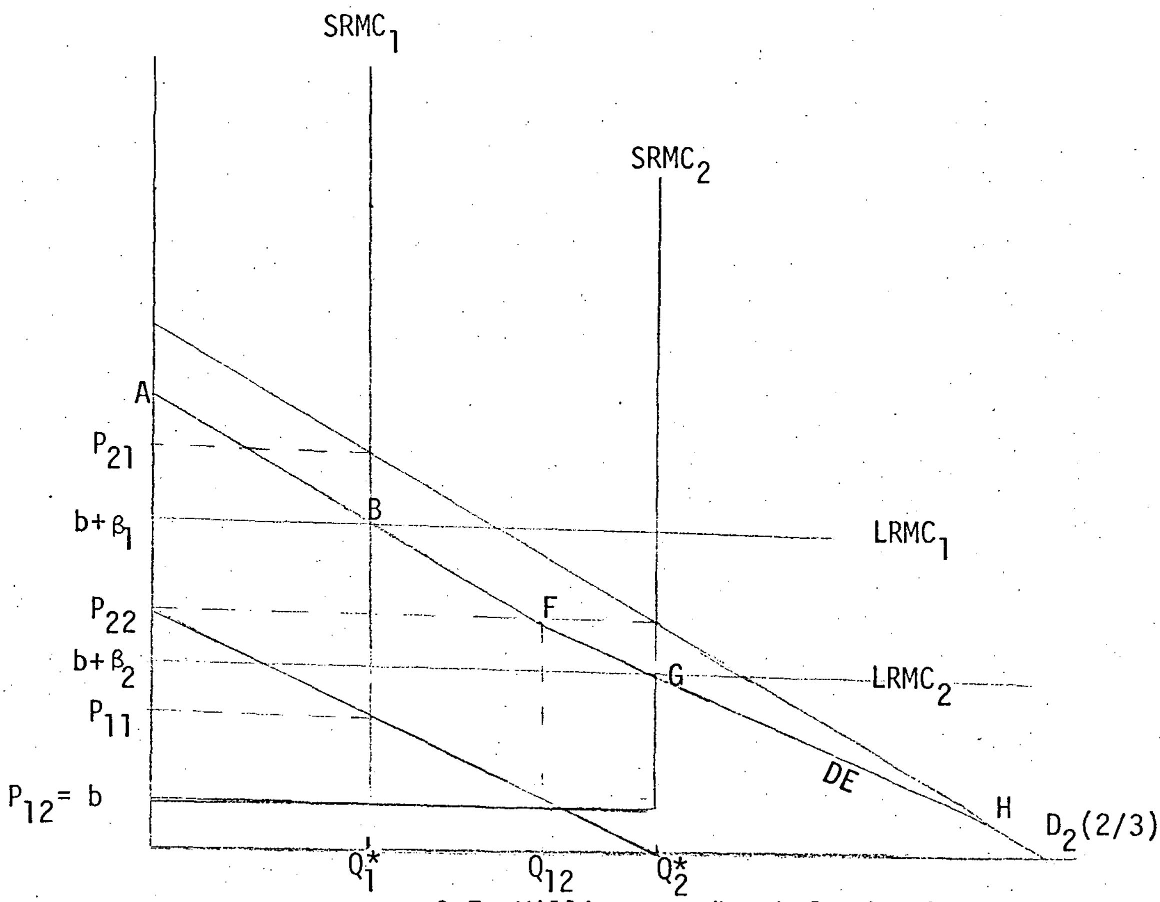
* This concept goes as far back as J. Dupuit, 1844. In its more contemporary form it was solved by P.O. Steiner, 1957.

Diagram II.



Source: O.E. Williamson, "Peak load pricing and optimal capacity under indivisibility contraints". *A.E.R.*, Vol. 36, Sept. 1966, p. 818.

The operating cost is assumed constant at b per unit. When capacity Q_1 is reached, the short run marginal cost (SRMC) becomes vertical. $SRMC_1$ and $LRMC_1$ correspond to the capacity available at Q_1, while $SRMC_2$ and $LRMC_2$ correspond to the capacity available at Q_2. The off peak demand curve, D_1, interests the $SRMC_1$ at P_{11}. The peak demand curve D_2, interest $SRMC_2$ at P_{21}; then P_{11} and P_{21} are the appropriate prices to levy during the off-peak and peak respectively. The justification is simply the fact that the cost of providing the service varies between the periods.

Intuitively, capacity is set to meet the highest level of demand. In the airline industry capacity is determined by the volume of true origin-destination traffic. The largest cost item for the airline industry is the cost of providing that level of capacity, once that capacity level is fixed and operational; operating outside the peak period would only incur the operating expenses. Thus as long as the operating cost is covered, it would be beneficial for the operator to maintain those services in the off peak.

This pricing strategy has often been confused with price discrimination. The two cases may be distinguished by looking at the marginal opportunity cost. A discriminating monopolist charges different prices to different consumer groups, however all consumers are served at the same marginal opportunity cost.[5] That is the value of the first unit of unsatisfied demand in the higher priced market is the most valuable alternative foregone.[6] In the peak pricing case, taking a unit away from the off peak period does not make it possible to supply a unit on-peak. Thus the higher on-peak value is not the relevant alternative social opportunity cost for the off peak demand.[7] Thus the marginal opportunity is different for both periods.

The construction of the effective demand curve (D_E) allows the optimum plant size to be solved for geometrically. In diagram II.2 the effective demand curve is obtained by taking the vertical difference between the periodic load curve and the SRMC(b), multiplying the difference by W_i (the fraction of the cycle during which load i prevails)

5. J. Hirshleifer, "Peak Loads and Efficient Pricing: Comment", *Quarterly Journal of Economics*, Vol. 71, 1958, p. 549.

6. *Ibid.*

7. *Ibid.*

and adding vertically their weighted demand for capacity curve to SRMC.[8] To match total revenue ($P_i\ Q_i\ W_i$) to total costs ($b\ Q_i\ W_i + \beta Q_i$), the price charged must equal $P_i = b + \beta/W_i$. The effective demand curve is constructed in such a manner that it intersects the LRMC at the capacity level Q_i, corresponding to the price $b + \beta/W_i$.[9] The intersection of the effective demand curve and the LRMC determines capacity. By setting the price at the intersection of the SRMC both the respective periodic load demand curves will ensure that net revenue is zero (i.e. $(b + \beta_1) - P_{11} = 2[P_{21} - (b + \beta_1)]$. Thus the amount by which revenue in the off-peak fails to cover pro rata the total cost, is precisely off-set by the revenue obtained in the peak period.

If the capacity costs were β_2 per unit per period, LRMC intersects D_E at G, thus the optimum plant size is Q_2. The prices are P_{12} and P_{22} in the off-peak and peak periods respectively. The kink at F in diagram II.2 indicates that the demand price along the off peak curve is everywhere below the SRMC.

This pricing strategy allows higher utilisation rates in the off peak and eliminates consumers from overloading the system in the peak. It should be noted that peak load pricing is not an attempt to eliminate growth in the peak period, but to pass on the correct signals to the consumer by making them aware of the costs they cause by travelling in the peak.[10] If a uniform pricing strategy were adopted it could lead to a growth in consumption at the peak periods which may result in additional investment in that good at the expense of alternative project

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8. O.E. Williamson, "Peak Load Pricing", *A.E.R.*, Vol. 56, Sept., 1966, p. 817.

9. *Ibid.*, p. 818.

10. R. Turvey and D. Anderson, *Electricity Economics* (John Hopkins University Press; Baltimore, 1977.

developments.

As noted earlier, this exposition of peak and off-peak pricing has been based on the assumption of independent demands in the two periods. In fact, high and low season demands for overseas travel are not independent, and a major objective of this study has been to quantify the interrelationship between high, shoulder and low season demands. As will be shown in Chapter 8, the solution to the problem is more complex when all of the cross-relationships are known, but the basic principle remains the same.

CHAPTER 3.

THE AUSTRALIA-U.S.A. PACIFIC ROUTE

The majority of Australian leisure travellers travel to either New Zealand, United Kingdom or the United States. New Zealand as a destination has always captured a large share of the Australian leisure travel market, however the rate of growth in the market has been declining while the United Kingdom and the United States have increased in popularity among Australian leisure travellers. The number of Australian residents travelling to the three major destinations for leisure can be seen in Table I.

TABLE I.

Australian Leisure Travellers Travelling to the 3 major overseas destinations.

Year	Total Leisure travellers (all overseas destinations)	Leisure Travellers to New Zealand	Leisure Travellers to the United Kingdom	Leisure Travellers to the United States
1972	504,519	113,502	43,912	38,115
1973	638,141	148,660	58,385	48,497
1974	769,650	180,376	123,661	52,224
1975	897,101	218,397	139,115	67,441
1976	950,457	220,210	122,736	87,293
1977	802,806	210,727	127,689	93,682
1978	1,062,235	209,733	195,559	108,085
1979	1,178,335	224,075	223,995	145,053
1980	1,203,601	217,740	188,311	144,084

Source: Australian Bureau of Statistics, *Overseas Arrivals and Departures*, Catalogue Number 3401.0

The figures in Table I only include short term movements, which is defined as a length of stay away from Australia being less than twelve months. They are true origin-destination figures.

The capacity provided by the airlines on the Australia-West Coast U.S.A. route for 1980 was 17 Boeing 747's per week.[1] This amounted to approximately 6,375 seats in either direction. This level of capacity is offered all year round; thus, the total number of seats available for 1980 was 331,500.

TICKET TYPES

The Australian government has pursued a policy of encouraging scheduled carriers to develop a range of promotional fares.[2] Increased fare flexibility allows the carriers to encourage travel from different market segments. If the fares and conditions of travel closely match the requirements of the traveller, this could lead to a growth in traffic. This growth in traffic could (if it does not require a proportional increase in capacity) lead to a decrease in per passenger costs.

Since 1970 on the Australia-West Coast U.S.A. route three major types of tickets have been available to the traveller.[3] The first two fares are the normal first class and economy class fares, these fares are free of any restriction. The third fare type is the advanced purchase fare (APEF) which was introduced on to this route in September 1973. The conditions attached to this fare are a minimum of length of stay in the destination country, no stop overs and payment for the ticket to be made 45 to 60 days in advance of the departure date.

1. Source: Qantas.
2. Report of Review Committee, *Australia's International Civil Aviation Policy,* Vol. 1, p. 24.
3. Source: Department of Transport, Canberra.

This fare offers savings to the traveller at all times of the year when compared to other fares. The advantages that accrue to the carrier are that they would be able to plan with more certainty if bookings are made in advance. Secondly the carrier has full access to payment in advance which reduced the problems of no-shows (penalties are attached on not travelling at the agreed time). Finally stop overs cannot be made, this reflects the economies gained by the carrier if the passenger travels end to end.

In February 1979, the airlines introduced seasonal pricing and applied it to the APEF fare. Thus if the potential traveller chooses to travel in the off peak travel season, he would save a considerable amount when compared to travelling in the shoulder or peak season. This pricing strategy was adopted in the hope that it would direct price sensitive travellers and potential travellers to change their demand for travel to periods when there is excess capacity.

CHAPTER 4.

SOME CHARACTERISTICS OF THE INTERNATIONAL LEISURE TRAVELLER

Travel demand studies have distinguished between two main travel purposes, that is travel for business and travel for leisure. Business travel has been seen to be motivated by increasing sales, and time is an important constraint to the business traveller. Leisure travel is discretionary travel; time of departure and arrival are not as important to the leisure traveller compared to the business man. Thus the type of service required by the two categories would tend to differ. Because of the time constraint the business traveller requires an on-demand service. He also requires a greater degree of comfort than the leisure traveller. Presumably if a businessman is to successfully conduct his business in distant places, his trip should be made as comfortable as possible. The businessman's on-demand service requirement also places an obligation on the carrier to provide a wide range of destinations, departure times (days of the week and time of day); the service must also be reliable.[1]

It has been observed that the leisure traveller is generally prepared to trade off lower fares for his comfort and generally lower product requirements. Qantas, in a report released in 1977, used factor analysing to separate out two market segments against the product features.[2] The results are present in Table 4.1. This analysis shows that there is a distinct difference in the product requirement for the two segments. Segment A can be said to represent the business traveller, while B represents the leisure traveller.

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1. Qantas, *A Review of International Air Services to and From Australia,* Submission to the House of Representatives Select Committee on Tourism, 1977.
2. *Ibid.*

TABLE 4.1

Qantas Analysis on Market Segments

Product Feature	Market Segment A	B
Flexibility	High	None
Choice of Destination	High	None
Choice of Time	High	None
Choice of Day	High	Low
Reliability	High	Moderate
Comfort	High	Low

Source: Qantas 1977. *A Review of International Air Services to and from Australia.* Submission to the House of Representatives Select Committee on Tourism.

Generally, the socio-economic characteristics of the two categories of travellers are different. The typical business traveller is male, middle aged and his income is usually high.[3] The leisure traveller exhibits a double hump age distribution, coming from the under 25 and over 50 age groups.[4] The income levels are usually low for the under 25s and moderate to high for the over 50s age group.

The differences presented here suggest that for modelling purposes the two types of traveller should be segregated and their travel behaviour should be modelled independently. This approach has been adopted by most of the recent studies in the area of travel demand

3. *Ibid.* 4. *Ibid.*

estimation.[5] This study concentrates on estimating demand for travel by leisure travellers. Many factors influence the decision to travel, broadly speaking these factors are part psychological (e.g. the weather) and institutional (e.g. leave periods). The psychological factors tend to make up the "pull" factors that motivate people to travel. Changes in institutional factors directly induce either increases or decreases in travel; these are termed "push" factors.

A. THE MOTIVATION AND "PULL" FACTORS

The motivation for leisure travel is a complex area, which is not easily modelled. Some insight can be gained from social scientists who have attempted to explain the phenomenon.

Travel is a derived demand. Few fly from A to B simply for the sake of flying, thus destination choice is important. In choosing a destination, the traveller would rely on his previous experience, the type of recreational facilities available at the destination, the hours of daylight, temperatures and the number of days of rain.[6] How much these factors influence travel behaviour is still unknown, however, it is undeniable that the above factors enter the traveller's frame of reference when deciding on a destination.

The need to travel also arises from the tourists' subjective needs. First, there is a need to relax, to escape from physical fatigue and nervous tension.[7] Secondly, there is a need to change the daily routine and to enjoy some of the rewards of earning a living.[8] Thirdly, there is a need to escape from the constraints, for which physical distance from normal surrounds is required.[9]

5. See Smith & Toms, M.R. Straszheim (1972), Edwards (1979), Oum & Gillen (1980), in Chapter 4.C.
6. European Conference of Ministers of Transport, *Holiday Traffic* (Paris, 1978), No. 4, p. 10.
7. *Ibid.*
8. *Ibid.*
9. *Ibid.*

The existence of these factors shows that there is a desire to experience new things and a general desire to get away. These desires can be fulfilled by travelling. Without these "pull" factors, changes in the "push" factors would have a very small effect on the growth of travel.

B. "PUSH" FACTORS

The push factors, outlined below, directly induce increased travel, by generation or by increasing the frequency of travel.[10]

(1) population growth and structure,

(2) income growth,

(3) income distribution between socio economic groups,

(4) general rate of domestic inflation,

(5) changes in the relative price of major items on which income may be spent,

(6) changes in periods of annual leave entitlements,

(7) facilities for domestic tourism and their prices,

(8) facilities for and the price of holidays abroad,

(9) new attractions for tourists, home and abroad,

(10) promotions and marketing of tourism at home,

(11) promotions and marketing of tourism abroad,

(12) social and other forces affecting consumer preference for spending income.

Most of the effects of the factors outlined above on travel are obvious. For instance as the population increases, it would be expected that the number of travellers would also increase. The population structures would also affect travel: if there are large numbers

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10. A. Edwards, *International Tourism Development Forecasts to 1990*, Economist Intelligence Unit (London, 1979), p. 14.

of elderly or very young people in the population, this could lead to a decrease in the number of travellers.

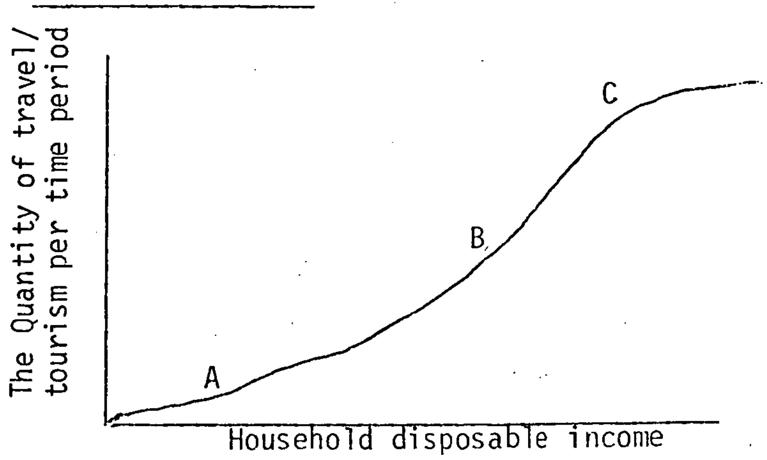
The length of annual leave periods and how they are taken would affect the type of travel, that is domestic versus international. The average length of paid annual holiday in Europe, U.S. and Australia is 4½ weeks.[11] Obviously the longer the period of paid annual holidays, the easier it becomes for workers to travel abroad.

However, recent trends have been towards decreasing the working week and tying in public holidays with weekends. The increase in leisure time in this manner would decrease the level of international travel as the time constraint reduces the number of destinations.

Income growth and its distribution among socio economic groups would also have an effect on travel. Travel has generally been accepted as a luxury good. Thus, as income increases, the number of leisure trips taken would also increase. Eventually a saturation point will be approached, and further increase in income would lead to a slower rate of increase in the demand for travel. This effect is shown in figure 4.1.

FIGURE 4.1

SATURATION EFFECT



Source: Edwards, R., *International Tourism Development Forecasts to 1990*, p. 37.

11. *Ibid.*, p. 40.

Figure 4.1 shows clearly that as disposable income increases, the quantity of tourism per period of time consumed increases at an increasing rate (A to B range), after which (at C) the rate of increase in consumption declines. This general pattern hides the effect of income distribution among socio-economic groups. Obviously disposable income levels are not the same for all households, thus the responsiveness of travel to their level of income would be different. For American travellers in 1975, G. Newman estimated income elasticities with respect to travel for different income classes. The results were:

TABLE 4.2.

Income Elasticity by Income Classes

Income, $',000: up to	$5	$5-10	$10-15	$15-20	$20-25	$25-50	$50+
Elasticity	0.7	1.4	2.1	3.7	3.4	1.5	1.1

Source: Newman, G., "Forecasting at Pan Am", from *Management of Tourism,* p. 216.

Clearly the rate of increase in household disposable income and the distribution of income are important variables that should be determined for forecasting future travel.

The rate of domestic inflation would affect the level of disposable income. The rate of inflation at the country of destination could also affect its relative attractiveness compared to other possible destinations.

The changes in relative prices of major items on which income may be spent will affect the level of consumption on the goods of interest and the mix in the consumption bundle. When looking at international travel, a likely alternative is domestic travel.

One factor not yet explicitly mentioned is the price of travel. The proportion of total tourist expenditure spent on travel has been estimated by Wheatcroft to be approximately 40%, being a major component of tourist expenditure. Any variations could lead to changes in destination, postponing travel or not travelling at all. The usual relation between price and demand is inverse; the higher the price the lower the demand. The prices of other goods and services affect the demand for tourism through their effect on general expenditure, thus a tourist may choose a less expensive form of tourism to have a greater amount available to spend on other items.[12] This tendency is particularly strong in the case of goods with a strong complement or substitute of another good. For instance the demand for a particular form of tourism may increase if offered in conjunction with a lower air fare. On the other hand, in the case of substitutes a fall in the price of a tour package may lead to a fall in demand for a competing package.

All these factors have provided the "push" for travel. How researchers have managed to model the demand for leisure travel will be seen in the next section.

C. <u>DEMAND STUDIES</u>

Past researchers have mainly used the ordinary least squares technique to estimate airline demand functions. In the modelling of air travel demand they appear to have been constrained by data which has limited the number of independent variable specified in the model.

12. B. Archer, *Demand Forecasting in Tourism*, Bangor Occasional Papers in Economics, No. 9, University of Wales Press, 1976, p. 2.

The two basic variables that have been used in air travel demand models are the fare and some measure of income. Other variables have been added to this basic model such as a time trend variable and an exchange rate/relative prices variable.

The effects of the fare and income on demand for air travel is well known. The time trend variable was included to capture the effect of changing technology: in view of the rapid technological advances made in the airline industry (e.g. wide-bodied jets) a time trend variable would seem to be appropriate. However, the trend variable may also pick up other effects: such as increases in population, and increases in real income over time. This effect would tend to mask the individual effects of other variables included in the model.

Straszheim (1969) estimated the demand for air travel across the North Atlantic from 1954 to 1964 using annual data. He adopted the following specification:[13]

$$\text{Ln } T = 6.5496 - \underset{(1.2308)^*}{0.3157 \text{ Ln Price}} - \underset{(1.538)^*}{0.7613 \text{ Ln Income}} + \underset{(7.9694)^*}{0.1825 \text{ time}}$$

$$R^2 = 0.9971$$

where:

Ln T = the log of all travellers from New York to London,
Ln Price = the log of the real New York to London fare,
Ln Income = the log of income,
Time = time trend.

The only significant variable in this model was the time trend; neither the price nor income coefficients were significant. The income coefficient was negative, thus it was unacceptable. The sign problems and the low t-statistics on the price and income variables would be

13. M.R. Straszheim, *The International Airline Industry* (Washington D.C., The Brookings Institute, 1969), p. 126.

* t-statistics.

due to a high correlation between the fare and income variables.

Possible solutions to breaking the correlation among the independent variables are to include more variables into the model, increase the number of observations or take first differences of the data. Brown and Watkins (1968) used the same variables as Straszheim on U.S. domestic air travel but took first differences in logs of the data.[14] They used annual data from 1946 to 1966; the results were:[15]

$$\Delta \text{Ln } T = 0.0725 - \underset{(4.491)}{1.307} \; \Delta \text{Ln } F + \underset{(2.922)}{1.119} \; \Delta \text{Ln } Y + \underset{(10.95)}{0.038} \text{ Ln } T$$

$$R^2 = 0.576$$

where:

Δ Ln T = first differences in logs of passenger miles per capita;

Δ Ln F = first differences in logs of average fares per mile in real dollars;

Δ ln Y = first differences in logs of real disposable income per capita.

T = time trend.

By this method they were able to obtain significant coefficients for both the fare and income coefficients which also had the expected sign. They also defined their variables to take account of size, that is, they divided the dependent and income variables by population. If size is not taken into account, total real disposable income may be observed to be increasing whereas this may simply be due to an increase in population.

14. S. Brown and W. Watkins, "A Regression Study of Time Series and Gross-sectional Data in the U.S. Domestic Market" (17th Annual Meeting of the Highway Research Board, Washington D.C., 1969), p. 9.

15. *Ibid.*, p.10.

When using cross section data for air travel demand modelling identification may be a problem. Similarly, the use of annual time series data may also lead to identification problems. The observation on price and quantity may represent a series of equilibrium points where both the demand and supply curves are shifting; thus the demand curve has not been properly identified. This could result in biased estimates. In this situation the researcher has observed both the consumer's reactions and the producer's reactions in the period under observation. To get around this problem, Straszheim and Brown and Watkins have assumed a fixed supply curve; that is the producers are assumed not to have reacted to changes in consumers' actions in that period. Their assumption may not be valid when using annual data.

Another solution is to use quarterly or monthly data thus increasing the validity of the assumption of fixed supply, i.e. producers do not respond to consumers' reactions in the same period. In the case of international air travel, the operators plan schedules and fares up to six months in advance and given the regulatory environment it is unlikely that the producers could change their fare and service package at short notice.

The characteristics of the leisure traveller has been outlined in some detail in Chapter 3. There is a general agreement that when modelling demand for air travel, business and leisure travellers should be modelled separately. Smith and Toms (1978) modelled international travel to and from Australia for business and leisure travellers separately. The results of the leisure travel model using pooled time series (March 1964 to March 1977 quarterly observations) and cross section data on seven countries were:[16]

$$\text{Ln DP} = \underset{(3.8)}{1.15} - \underset{(-19.88)}{1.78}\ \text{Ln F} + \underset{(12.3)}{2.36}\ \text{Ln Y} + \underset{(3.3)}{0.55}\ \text{Ln E} + \underset{(34.5)}{0.48}\ \text{Ln MA}$$

$$+ \underset{(12.6)}{0.57}\ \text{SD} - \underset{(-7.3)}{0.52}\ \text{CD}_2 - \underset{(-7.2)}{1.16}\ \text{CD}_5$$

$$R^2 = 0.92$$

where:

- Ln DP = the log of per capita demand for leisure travel from Australia,
- Ln F = the log of the real equivalent air fare,
- Ln Y = the log of the real per capita income,
- Ln E = the log of the exchange rate index,
- ln MA = the log of the proportion of the Australian population born in the overseas country of destination of travel,
- SD = a seasonal dummy variable,
- CD_2 = a dummy variable for Italy,
- CD_5 = a dummy variable for New Zealand.[17]

The fare variable used in this model was unique; it is a combination of the real air fare and a conversion of the eligibility condition into monetary terms. All the variables carry the expected signs and are significant. The large fare coefficient is consistent with the belief that leisure travellers are price elastic.

Smith and Toms introduced a new variable to air travel demand modelling: the exchange rate index. This variable was defined in Australian dollars and was thought to influence the purchasing power of Australians visiting other countries.[18] Thus a 1% change in the

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16. The seven countries were: Germany, Italy, Japan, Malaysia/Singapore, New Zealand, United Kingdom and United States.

17. A.B. Smith and J.N. Toms, "Factors Affecting Demand for International Travel to and from Australia" (Canberra, A.G.P.S., 1978), p. 66.

18. *Ibid.*, p. 23.

exchange rate index in favour of Australia would induce an increase in the number of Australian leisure travellers by 0.55% (holding all other variables constant).

Besides the pooled time series/cross section estimation of travel demand, Smith and Toms also estimated the travel demand function for seven countries using time series data. The results for Australian leisure travellers travelling to the U.S. are:[19]

$$\text{Ln DP} = \underset{(-5.2)^*}{-1.67\ \text{Ln F}} + \underset{(10.7)^*}{3.32\ \text{Ln Y}} + \underset{(13.2)^*}{0.60\ \text{SD}}$$

$$R^2 = 0.965, \qquad \text{D.W.} = 2.03$$[20]

The dependent variable is the log of per capita demand for leisure travellers from Australia to the U.S.; other variables are defined as before. The results are consistent with past research on leisure travellers. The significance of the seasonal dummy shows that the timing of travel is dependent on the season. The seasonal dummy used here equals 1 in the June and September quarter which corresponds to the peak and shoulder months of travel.

The Smith and Toms estimation of travel demand for each individual country suffered from serial correlation problems: one cause of this problem is the omission of important variables. One such variable that they omit from the model is the exchange rate index which was a significant variable in their pooled equation. Smith and Toms state that they only included variables that were significant;[21] however, omitting variables from a well specified model may lead to specification

19. *Ibid.*, p. 68.
 * t-statistics.

20. This equation was estimated using the Cochrane-Orcutt transformation for serial correlation.

21. Smith and Toms, "Factors Affecting International Travel to and from Australia (Canberra, A.G.P.S., 1978), p. 28.

errors,[22] and bias the estimates of the remaining coefficients in the equation.

The exchange rate/relative price variable has been used extensively in studies on tourist expenditure. Generally the relative price variable is a composite variable containing the effects of the rate of inflation in the origin country and the country of destination adjusted for exchange rate movements.

Artus (1978) developed a model to explain foreign travel expenditure flows. In his model local currency prices and the exchange rate were separated. This was done because he felt that the adjustment period for the two variables may be different in the short run: that is buyers of foreign travel are more likely to be aware of exchange rate movements than of changes in the country of destination's local currency prices.[23]

The dependent variable in his model was country's per capita real spending on foreign travel in year T. The independent variables were:[24]

1) the real per capita disposable personal income in country i;
2) relative local currency prices of travel services in country i and abroad; and,
3) relative prices of foreign exchange in country i and abroad.

For U.S. travel to Canada - the relative local currency price elasticity was -3.74 and the exchange rate elasticity was -2.38; their respective t-statistics were -3.63 and -6.20.[25]

Other researchers have combined both effects into one variable:

22. M.D. Intriligator, *Econometric Models, Techniques and Applications*, (New Jersey, Prentice Hall Inc.: 1978), p. 155.

23. J. Artus, "An Econometric Analysis of International Travel", I.M.F. Staff Papers, 1978, p. 590.

24. *Ibid.*

25. *Ibid.*, p. 596.

the relative price variable. Jud and Joseph estimated international demand for Latin American tourism; their dependent variable was the aggregate dollar expenditure of U.S. citizens in the i^{th} region.[26] The independent variables were real disposable income and relative prices. The results for their equation (with t-statistics in brackets) excluding Mexico was:[27]

$$\text{Lm Mi} = \underset{(6.565)}{4.215} + \underset{(24.00)}{2.04} \text{ Ln Income} - \underset{(3.756)}{1.845} \text{ Ln relative prices}$$

$$R^2 = 0.987, \quad \text{D.W.} = 1.93$$

These results indicate that the relative price variable should be included in models estimating the demand for international air travel. The vacation package comprises a complex set of interactions: the price of travel, accommodation costs, entertainment costs and meal costs. The prices at a destination country relative to the originating country would be expected to influence the length of stay of the travellers and act as a proxy to costs other than the fare.

Over the last ten years airline operators have come to recognise the existence of sub markets within the overall travel market. They have pursued pricing policies to attract these different types of travellers. Transport economists have been putting more effort towards estimating the effect of different fares on these submarkets and at estimating the cross relationship between fare classes. The results of these studies are of interest because they show the present state of the art in estimating air travel demand functions and may give some insight into the effects of seasonality on travel.

Oum and Gillen (1980) estimated the cross relationship between

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26. Jud and Joseph, "International Demand for Latin American Tourism", *Growth and Change*, January, 1974, p. 29.

27. *Ibid*.

three different fare classes on the U.S. domestic trunk routes. The three fare classes were: first class, standard economy class and discount fare class.[28] A system of demand functions for the three fare classes were derived; they were then estimated jointly by a multivariate nonlinear least squares method using route specific cross-sectional yearly data (1978) on U.S. domestic routes.[29] They adopted a translog functional form. The range of elasticities from their model is shown in Table 4.4.

TABLE 4.4

Oum and Gillen's Estimated Elasticities Range.

Elasticities	Range
a) Own Price	
First Class	-0.85 to -0.95
Economy Class	-1.31 to -1.50
High Discount	-1.50 to -1.90
b) Cross Price	
Economy - High Discount	0.28 to 0.45
High Discount - Economy	0.60 to 1.00
c) Substitution	
First - Economy	0.89 to 1.00
Economy - High Discount	2.00 to 2.40
Economy - First	0.77 to 0.89
d) Total Route Expenditure	
First	
Economy	
High Discount	0.91 to 0.94

Source: Oum & Gillen, "A Study of Inter-Fareclass Competition in the Airline Markets", *Transport Research Forum* (1980), p. 607.

28. T.H.Oum and D.N.Gillen, "A Study of Inter-fareclass Competition in Airline Markets", *Transport Research Forum*, 1980, p. 599.
29. *Ibid.*

The own price elasticities are consistent with the belief that first class travellers are price inelastic, while the economy and high discount fare class travellers are more sensitive to price. This is because the proportion of leisure travellers is greater in the economy and high discount fare class.

The estimated cross elaticities show two important results: firstly, the strong cross price elasticity of the high discount fare with respect to the economy fare. The airlines have claimed in the past that the high discount fare has eroded the standard economy class market.[30] The cross price elasticity estimated for the high discount fare with respect to the economy fare suggests that if the economy fare were reduced by 1%, between 0.6% and 1% of the high discount travellers would switch to travelling on economy fares. The second important finding is that the first class fare has no significant cross relationship with any other fareclass. It tends to support the practice of separating business and leisure travellers in travel demand estimation.

The representative fare used in the model is important. Kanafani and Sadoulet (1977) have shown that the seasonal distribution is different for different fares. For example, while the peak is the most attractive travel season for all travellers, its relative attractiveness is highest for excursion travellers.[31] This indicates that excursion fare should probably be used as the fare variable in the peak season when modelling leisure travellers. Because of the complex interaction in this market and their relative sensitivity to price, the cross elasticities should be considered when developing either a commercial or public policy aimed at pricing variation travel.

It is possible to generate a complete set of demand elasticities

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30. *Ibid.*, p. 607.

31. A. Kanafaní and E. Sadoulet, "The Partitioning of Long Haul Air Traffic - a study in mültinominal choice", Transport research (1977), Vol. II, p.6.

for the vacation travel market from available elasticity estimates. The missing elasticities may be inferred by constraining the demand system to satisfy the known conditions applying to elasticities in the system.[32] These conditions are:[33]

1) Homogeneity - in each demand equation the own price, cross price and income elasticities sum to zero.
2) Symmetry - if Eij is the cross elasticity of demand for i with respect to the price of j and Eji is defined similarly, then $Eij = (Rj/Ri)\ Eji + Rj\ (Ejy - Eiy)$.
   Where Rj, Ri are proportions of total expenditure, and Eiy, Ejy are income elasticities of demand.
3) Cournot column aggregation $\sum_i Ri\ Eij = -\ Rj$
4) Engel aggregation $\sum_i Ri\ Ejy = 1$

By this method Taplin (1980) was able to synthesize a demand matrix for vacation travel.[34] This is clearly not the most preferred method to approach the problem of estimating cross elasticities, however, given the data constraints it may be a good approximation.

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32. A good discussion of the known conditions applying to the elasticities in a demand system is provided by Brown, A. and Deaton, A., "Surveys in Applied Econometrics: Models of consumer behaviour", *Economic Journal*, Vol.82, pp. 1145-1236.

33. J.H.E. Taplin, "A Coherence Approach to Estimates of Price Elasticities in the Vacation Travel Market", *Journal of Transport Economics and Policy*, January, 1980, p. 20.

34. The synthesized matrix appears in Appendix A.

CHAPTER 5.

MODEL SPECIFICATIONS AND DATA

The previous chapter showed the techniques and results for various studies on airline demand. Estimation techniques have become increasingly sophisticated and as more data has become available, the number of explanatory variables used has increased. The literature search revealed no previous work on estimating seasonal demand functions. With the knowledge obtained from previous studies and the available data a model is specified to try to capture the cross relationships between travel seasons.

The main interest in this study lies in the estimation of the cross relationships between travel seasons; there are two ways of setting up the model. The first method is to set up a demand equation for each travel season and estimate each season separately.[1] However, this specification would not allow for tests of serial correlation: as serial correlation typically occurs with the use of time series data, it would be advisable to test for it.[2] Thus the second approach is adopted, that is to use a single equation specification. This single equation uses dummy variables to create interaction terms which allows variables to be switched on and off depending on the travel season.

Serial correlation leads to estimates that are no longer efficient and to bias in the estimation of the variance of the disturbance term. This is a problem when using time series data because the stochastic disturbance terms may be related to each other. A shorter time span

1. The separate equations were estimated, mainly to satisfy the researchers that the results could be reproduced by the single equation - see Appendix B for results of separate equation.

2. M.D. Intriligator, *Economic Models, Techniques and Applications* (Prentice Hall, New Jersey, 1978), p. 159.

between observations may alleviate the problem of identification, but it would increase the likelihood of encountering serial correlation.

A. SINGLE EQUATION SPECIFICATION

The general relationship for this problem may be given as:

LNT = f (LNLF, LNSF, LNPF, AXUS, AXUK, Y)

(Eq. 1)

where

LNT = the number of trips per head of leisure traveller,

LNLF = the real advanced purchase fare available in the low period,

LNSF = the real advanced purchase fare available in the shoulder period,

LNPF = the real advanced purchase fare available in the peak period,

AXUS = the U.S. to Australia relative prices,

AXUK = the U.K. to Australia relative prices,

Y = the real per capital disposable income.

This basic model will not yield any cross elasticities between travel seasons. The travel seasons as given by the Department of Transport for Australian residents travelling to the U.S. were:

(a) low period: February, March, October and November.

(b) shoulder period: April, 1-15 July, September, 1-15 December and January.

(c) peak period: May, June, 16-31 July, September, 1-15 December.

Because of the difficulties involved in using the split months in the regression, it was decided to pool the split months into either a shoulder or a peak period. To justify which months fell into which travel season, the monthly departures from 1974 to 1980 were used to help determine which season the split months would fit. The low period was kept intact, while the shoulder and peak periods are now given as:

(a) low period: February, March, October and Nobember.

(b) shoulder period: January, April, July and September.

(c) peak period: May, June, August and December.

It is known that leisure travellers are influenced by the published fares in other travel periods. These fares and conditions are published up to six months in advance. Thus in any one travel period, with a little research, the potential traveller would most likely be aware of the other fares. This influence of the other fares available in any one travel period must be accounted for in the model. For this purpose interaction terms/slope shifters are introduced into the model. The generation of the interaction terms is quite simple. For instance, to generate the shoulder fare interaction term the shoulder fare is multiplied by the shoulder dummy variable (the shoulder dummy equals 1 for January, April, July and September, 0 otherwise). The interaction terms are also generated for the U.S., U.K. relative prices and income variables.

Twelve monthly dummy variables have also been incorporated into the model. The dummy variables pick up the seasonal effects and the end effects. The seasonal effects are important and have been discussed. The end effects refer to the effect of a potential traveller delaying his trip in order to take advantage of the lower fares offered at other periods. If a leisure traveller considers making his trip towards the end of a peak month (e.g. December) he may delay his trip till January to take advantage of the lower fares in January, a shoulder month. The final model specification is:

$$\begin{aligned}
\ln LNT = {} & a_1 DJ + a_2 DF + a_3 DM \pm a_4 DA + a_5 DMY + a_6 DJN + a_7 DJL \\
& + a_8 DAG + a_9 DST + a_{10} DPC + a_{11} DNV + a_{12} DDC. \\
& + b_1 \text{ Ln } LNLF + b_2 \ln LNSF + b_3 \ln LNPF \\
& + c_1 D_s (\ln LNLF) + c_2 D_s (\ln LNSF) + c_3 D_s (\ln LNPF) \\
& + c_4 D_p (\ln LNLF) + c_5 D_p (\ln LNSF) + c_6 D_p (\ln LNPF) \\
& + d_1 \ln AXUS \\
& + d_2 D_s (\ln AXUS) + d_3 D_p (\ln AXUS) \\
& + e_1 \ln AXUK \\
& + e_2 D_S (\text{Ln } AXUK) + e_3 D_p (\ln AXUK) \\
& + f_1 \ln RDYM \\
& + f_2 D_s (\ln RMYM) + f_3 D_p (\ln RDYM) \\
& + U \qquad \text{(Eq. 2)}
\end{aligned}$$

where

ln LNT = the log of leisure trips per capita,

DJ = dummy January = 1; 0 otherwise,

DF = dummy February = 1; 0 otherwise,

DM = dummy March = 1; 0 otherwise,

DA = dummy April = 1; 0 otherwise,

DMY = dummy May = 1; 0 otherwise,

DJN = dummy June = 1; 0 otherwise,

DJL = dummy July = 1; 0 otherwise,

DAG = dummy August = 1; 0 otherwise,

DST = dummy September= 1; 0 otherwise,

DOC = dummy October = 1; 0 otherwise,

DNV = dummy November = 1; 0 otherwise,

DDC = dummy December = 1; 0 otherwise,

$\ln LNLF$ = the log of the published real advanced purchase low fares,

$\ln LNSF$ = the log of the published real advanced purchase shoulder fares,

$\ln LNPF$ = the log of the published real advanced purchase peak fares,

D_s = dummy representing months in the shoulder period:

January = 1
April = 1
July = 1
September = 1

zero otherwise,

D_p = dummy representing months in the peak period:

May = 1
June = 1
August = 1
December = 1

zero otherwise,

$D_s(\ln LNLF)$ = the log of the real advanced purchase low fares multiplied by the shoulder dummy,

$D_s(\ln LNSF)$ = the log of the real advanced purchase shoulder fare multiplied by the shoulder dummy,

$D_s(\ln LNPF)$ = the log of the real advanced purchase peak fare multiplied by the shoulder dummy,

$D_p(\ln LNLF)$ = the log of the real advanced purchase low fare multiplied by the peak dummy,

$D_p(\ln LNSF)$ = the log of the real advanced purchase shoulder fare multiplied by the peak dummy,

$D_p(\ln LNPF)$ = the log of the real advanced purchase peak fare multiplied by the peak dummy,

$\ln AXUS$ = the log of the U.S. to Australia relative prices,

$D_s(\ln AXUS)$ = the log of the U.S. relative prices multiplied by the shoulder dummy,

$D_p(\ln AXUS)$ = the log of the U.S. relative prices multiplied by the peak dummy,

$\ln AXUK$ = the log of the U.K. to Australia relative prices,

$D_s(\ln AXUK)$ = the log of the U.K. relative prices multiplied by the shoulder dummy,

$D_p(\ln AXUK)$ = the log of the U.K. relative prices multiplied by the peak dummy,

$\ln RDYM$ = the log of the real per capita monthly disposable income,

$D_s(\ln RDYM)$ = the log of the real per capita monthly disposable income multiplied by the shoulder dummy,

$D_p(\ln RDYM)$ = the log of the real per capita monthly disposable income multiplied by the peak dummy,

U = an additive disturbance term.

a_1 to a_{12}, b_1 to b_3, c_1 to c_6, d_1 to d_3, e_1 to e_3 and f_1 to f_3 are parameters to be estimated.

The U.S. relative price variable is a composite variable, generated by dividing the U.S. Consumer Price Index by the Australian Consumer Price Index then adjusting for exchange rate movements. This variable represents a proxy for accommodation and meal costs incurred by the traveller in the U.S. As Wheatcroft pointed out this could represent up to 60% of the traveller's total travel budget.[3] The variable is expected to be negatively related to the number of leisure trips by Australians travelling to the U.S.A. per capita.

The U.K. relative prices variable was calculated in a similar manner to the U.S. relative prices. The variable represents an alternative destination for U.S. bound travellers, as leisure travellers are price sensitive they may be swayed by the costs associated with each competing destination. Further, the travel data used is based on

3. S. Wheatcroft, Transport and Tourism, ed. R.J. Burkart and S. Medlik, *The Management of Tourism* (London: Hinneman, 1978).

a true origin-destination classification, therefore it is possible that some travellers may have travelled to the U.S. via Europe. In the case of leisure travellers this would be expected to be only a very small proportion of travellers, if any.

Each travel period will have its own own-price elasticity and this is expected to be negatively related to travel demand. Further, as the fares for other travel periods are known in any one travel season, potential travellers will be affected to some extent by all the fares offered. Thus the cross price elasticities between fares are expected to be positively related to travel demand in any one period, that is travel in the peak period is a substitute for travel in the low period. The travel period used as a base in this model is the low travel period.

If this model were to include interaction terms for the low period as well as the other fare variables, the least square estimates for the coefficients would be indeterminate. The interaction terms and the constant (in this case LNLF, LNSF, LNPF) would have a perfect linear correlation with each other.[4] Thus ohe less set of interaction terms than the number of periods being represented solves this problem. The interaction terms represent the marginal changes for the slope of the shoulder and peak period fares, the U.S. and U.K. relative prices and the shoulder and peak real monthly disposable income per capita. To obtain the elasticities associated with those periods, the coefficients on the constants must be added to the coefficient of the respective interaction terms.

Another method of specifying the same model is to drop out the constant terms (i.e. LNLF, LNSF, LNPF, LNAXUS, LNAXUK, LNRDYM) and

4. J.L. Murphy, *Introductory Econometrics* (R.D. Irwin, Inc., Illinois, 1923), p. 267.

substitute in the interaction terms for the low period. In this manner the elasticities for the low, shoulder and peak periods may be read off directly from the model. Thus the alternative specification is:

$$\begin{aligned} \ln LNT = {} & a_1 DJ + a_2 DF + a_3 DM + a_4 DA + a_5 DMY + a_6 DJN + a_7 DJL \\ & + a_8 DAG + a_9 DST + a_{10} DOC + a_{11} DNV + a_{12} DDC \\ & + b_1\ D_L(\ln LNLF) + b_2\ D_L(\ln LNSF) + B_3\ D_L(\ln LNPF) \\ & + b_4\ D_S(\ln LNLF) + b_5\ D_S(\ln LNSF) + b_6\ D_S(\ln LNPF) \\ & + b_7\ D_p(\ln LNLF) + b_8\ D_p(\ln LNSF) + b_9\ D_p(\ln LNPF) \\ & + c_1\ D_L(\ln AXUK) + c_2\ D_S(\ln AXUS) + c_3\ D_p(\ln AXUS) \\ & + d_1\ D_L(\ln AXUK) + d_2\ D_S(\ln AXUK) + d_3\ D_p(\ln AXUK) \\ & + e_1\ D_L(\ln RDYM) + e_2\ D_S(\ln RDYM) + e_3\ D_p(\ln RDYM) \\ & + U \qquad \text{(Eq. 3)} \end{aligned}$$

where

$D_L(\ln LNLF)$ = the log of the real advanced purchase low fare multiplied by the low dummy,

$D_L(\ln LNSF)$ = the log of the real advanced purchase shoulder fare multiplied by the low dummy,

$D_L(\ln LNPF)$ = the log of the real advanced purchase peak fare multiplied by the low dummy,

$D_L(\ln AXUS)$ = the U.S. relative prices multiplied by the low dummy,

$D_L(\ln AXUK)$ = the U.K. relative prices multiplied by the low dummy,

$D_L(\ln RDYM)$ = the real monthly disposable income per capita multiplied by the low dummy.

The other variables are as defined for equation 2. Both equation 2 and 3 should yield the same results. The advantage of using equation 3 is that it eliminates the extra computation needed to arrive at the elasticities for each period in equation 2. Also the significance tests (t-statistics) can be applied directly to the coefficients estimated in equation 3; in equation 2, a series of F-tests are required to test for significant slope changes.

B. THE DATA

Monthly time series data was used in the model from January 1974 to December 1980, giving a total of 84 observations. As in most econometric models, some of the data had to be adjusted to provide a compatible series of observations.

The dependent variable, leisure trips per head was derived from two publications put out by the Australian Bureau of Statistics (A.B.S.). The number of Australian true origin-destination leisure travellers travelling to the U.S. each month came from the A.B.S. bulletin, *Overseas Arrivals and Departures*.[5] This data is normally presented by quarters, but monthly data may be obtained from the A.B.S. in Canberra. Leisure travellers are defined as those travelling to the U.S. for the purpose of having a holiday or visiting friends and relatives.

The monthly leisure travellers figures were then divided by the Australian population. The population figures came from the A.B.S. *Demography Bulletin*,[6] which presented population figures on an annual basis. An interpolation method based on the assumption of the series being a multiplicative one was used to drive monthly observations.[7]

The normal first and economy fares were not used, as the majority

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5. A.B.S., *Overseas Arrivals and Departures*, Catalogue number
6. A.B.S., *Demography Bulletin*, Catalogue number 3101.0.
7. See Appendix C.1 for interpolation of population series.

of users would be business travellers.[8] The lowest available fare on the route was the Budget fare, however it was excluded on the grounds that it was only available from 1979 to 1980; it was not in operation for the entire period of the study. Thus, it was decided to use the advanced purchase fare (APEF) to represent the fare available to leisure travellers on the Australia-U.S.A Pacific route.

The group inclusive tour (G.I.T.) fares were not considered to be appropriate for the study, as they are offered by the airline operators to the travel trade. The G.I.T. fare is a discounted fare, around which an inclusive tour can be packaged. This fare is normally higher than the economy class fare and attracts mainly first time travellers and some price sensitive travellers who are willing to pay for the convenience offered by the G.I.T. fare.[9] It was decided not to use this fare because the G.I.T. fare contained a landed component of the trip, i.e. accommodation costs. Thus an estimate of its fare elasticity could be biased upwards.

The only conditions attached to the APEF fares are advanced booking and purchase, cancellation penalties and no stop overs. It is the lowest priced fare available on the Australia-U.S.A. route throughout the study period: a potential traveller could save 30% to 50% on the economy class fare. The APEF fare was considered to be the appropriate fare to use for the study because it was available throughout the period under study and it is a fare that the airline operators used specifically to attract more leisure travellers.

The APEF fares were then deflated by the Australian Consumer

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8. Smith and Toms, ticket survey on the U.K. route, showed a predominance of business travellers using full first & economy class fares. See Chapter 3.

9. Report of the Review Committee, *Australia's International Civil Aviation Policy*, Vol.2, p. 228.

Price Index obtained from the *Monthly Statistics* bulletin.[10] The base year for that series was 1970, thus the fares when deflated yielded 1970 dollar values. The data was given in quarterly observations and an interpolation method assuming the series to be multiplicative was used to obtain monthly observations.[11]

The U.S. relative prices is a composite variable, generated by dividing the U.S. Consumer Price Index by the Australian Consumer Price Index then adjusting for exchange rate movements.[12] The same method was used to obtain the U.K. relative prices. Thus a higher U.S. to Australia C.P.I. ratio reflects a higher inflation rate in the U.S. which in turn reflects a higher cost of living. At the same time, if the exchange rate moved in favour of Australia (i.e. an Australian dollar now buys more U.S. dollars), the effect of the higher cost of living may be offset. However, if the exchange rate moved in favour of the U.S. (i.e. an Australian dollar now buys less U.S. dollars), it would compound the effect of a higher cost of living and make the U.S. a less attractive destination due to higher costs. The U.S. relative prices variable in Table D.5 of Appendix D, shows that the general trend has been in the U.S's favour up to 1979, then it gradually moved against the U.S. The U.K. relative prices (Table D.6 of Appendix D.) shows that it has moved consistently in Australia's favour.

The U.S. and U.K. Consumer Price Indices were obtained from the *Statistics Bulletin*, which gave monthly observationas with 1970 as the base year. The exchange rate used was the buying rate of the Australian dollar to the U.S. dollar and the U.K. pound. The exchange

10. A.B.S., *Monthly Statistics*, Catalogue No. 1304.0.
11. See Appendix C.2 for interpolation of the C.P.I. series.
12. See Appendix D for an example of the construction of the relative prices variables.

rate data came from the A.B.S. *Banking Australia Quarterly Bulletin*, which gave monthly observations.[13]

To calculate the real disposable monthly income per capita three steps were taken. Firstly, household disposable income was given in the A.B.S. *Quarterly Estimates of Income and Expenditure* publication, by quarters:[14] this data was interpolated to obtain monthly observations.[15] These monthly observations on household disposable income were then divided by the Australian population to obtain a per capita figure for disposable income. Finally, the series was deflated by the Australian C.P.I.

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13. A.B.S., *Banking Australia Quarterly*, Catalogue No. 5605.0.
14. A.B.S., *Quarterly Estimate of Income and Expenditure*, Catalogue No. 5206.0.
15. See Appendix C.3 for interpolation of household disposable income data.

CHAPTER 6.

THE RESULTS OF THE SINGLE EQUATION ESTIMATION

A common approach to estimating a demand function with possible class differences is to estimate an equation for each class.[1] However, it was pointed out earlier that by estimating separate equations the normal tests for serial correlation are invalid. As serial correlation problems occur frequently when using time series data it is important that tests for it be undertaken. The advantages associated with estimating a separate equation for each class are flexibility, that is it allows for changes in all coefficients among classes, and specification error is less likely to occur.[2]

The use of dummy variables allows the creation of interaction terms which permit the slopes to vary. This form of specification in a single equation is equivalent to estimating separate equations for each class.[3] Thus, the estimated coefficients will be the same using either method.

The use of interaction terms allows for certain computational convenience; it permits the estimation of class differences in one step.[4] The number of equations required in the separate equation approach would depend on the number of classes. There is also a greater number of degrees of freedom associated with a single equation. The main disadvantage is that there is a greater danger of specification error in using dummy variables.[5]

In the previous chapter two specifications of the single equation

1. S. Ben-David and N.G. Tomek, *Allowing for Slope and Intercept Changes in Regression Analysis* (Cornell University, 1965), p. 2.
2. *Ibid.*, p.3
3. *Ibid.*, p.4.
4. *Ibid.*, p. 4.
5. *Ibid.*, p. 5.

were presented, both giving identical results. Equation 2 in Chapter 5 had the original (non-dummy) independent variable incorporated into the model. This variable represented the base travel period and the coefficients estimated on the interaction terms gave the marginal changes associated with that interaction term. Equation 3 in Chapter 5 did not contain a non-dummy independent variable. It was replaced with the low period interaction terms. Thus each interaction term in equation 3 no longer represent marginal changes with respect to the base period, but represent changes wholly for their respective periods.

The results of the estimates on the coefficients for equations 2 and 3 are presented in Table 6.1.

TABLE 6.1

Results of Estimates for Equations 2 and 3[A,B]

Equation Number	2	3
Dependent	Leisure travellers per capita	Leisure travellers per capita
Independent Variables		
DJ	-8.0752 (-1.038)	-8.0752 (-1.038)
DF	6.2097 (0.5613)	6.2097 (0.5613)
DM	6.5262 (0.5929)	6.5262 (0.5929)
DA	-7.9276 (-1.0271)	-7.9276 (-1.0271)
DMY	-3.3827 (-0.4415)	-3.3827 (-0.4415)
DJN	-3.6871 (-0.4818)	-3.6871 (-0.4818)
DJL	-7.6488 (0.9924)	-7.6488 (-0.9924)
DAG	-3.3716 (-0.4388)	-3.3716 (-0.4389)
DST	-7.8549 (-1.0165)	-7.8549 (-1.0165)

contd.

TABLE 6.1 contd.

Equation Number		2	3
Dependent		Leisure travellers per capita	Leisure Travellers per capita
	Independent Variables		
	DOC	6.6208 (0.5962)	6.6208 (0.5962)
	DNV	6.4145 (0.5754)	6.4155 (0.5754)
	DDC	-3.2871 (-0.4202)	-3.2871 (-0.4202)
Independent Variables in Eq. 2.	Independent Variables in Eq. 3.		
LNLF	DLLNLF	-0.8938 (-3.2774)	-0.8938 (-3.2774)
LNSF	DLLNSF	-0.4746 (-0.9441)	-0.4746 (-0.9441)
LNPF	DLLNPF	-0.0573 (-0.0622)	-0.0573 (-0.0622)
DSLNSF	DSLNLF	0.8456 (1.9769)	-0.0482 (-0.1463)
DSLNSF	DSLNSF	-0.5112 (-0.7244)	-0.9858 (-1.99)
DSLNPF	LSLNPF	0.6345 (0.4195)	0.5772 (0.4809)
DPLNLF	DPLNLF	0.7566 (2.0017)	-0.1371 (-0.5239)
DPLNSF	DPLNSF	1.1814 (1.6132)	0.7068 (1.3272)
DPLNPF	DPLNPF	-1.1637 (-0.0462)	-1.2209 (-1.4966)
LNAXUS	DLAXUS	-0.7236 (-0.9856)	-0.7236 (-0.9856)
DSAXUS	DSAXUS	-3.3029 (-2.48)	-4.0266 (-3.6239)
DPAXUS	DPAXUS	-2.3891 (-2.6883)	-3.1107 (-6.2283)
LNAXUK	DLAXUK	2.6597 (3.898)	2.6597 (3.898)
DJAXUK	DSAXUK	-2.7176 (-2.1146)	-0.0579 (-0.0531)

contd.

TABLE 6.1 contd.

Equation Number		2	3
Dependent		Leisure travellers per capita	Leisure travellers per capita
Independent Variables in Eq. 2	Independent Variables in Eq. 3.		
DPAXUK	DPAXUK	-0.4614 (-0.4419)	2.1984 (2.7826)
LNRDYM	DLRDYM	-1.0882 (-0.8857)	-1.0882 (-0.8856)
DSRDYM	DSRDYM	1.3727 (0.9971)	0.2845 (0.4581)
DPRDYM	DPRDYM	0.8882 (0.5539)	-0.1999 (-0.1942)
	R^2	0.9448	0.9448
	D.F.	54	54
	D.W.	1.584	1.584

(A) t-statistics are in parenthesis

(B) the variables are defined as in Chapter 5.

For equation 2 an extra step is required before the elasticities can be obtained. The interaction terms for the shoulder and peak period in equation 2 represent the marginal changes in those periods. To obtain elasticities the estimated coefficients for those interaction terms must be added to the corresponding estimated coefficients for the base period (in this case the low travel season). The results of this adding up step are presented in Table 6.2.

Comparing the results of the computed elasticities for equation 2 in Table 6.2 with the elasticities obtained in equation 3, show the results to be the same. Thus either formulation may be used.

TABLE 6.2[A]

Elasticities obtained from equation 2.

Travel Period	Low	Shoulder	Peak
Variables			
1) Fare:			
Low	-0.8938	-0.0481	-0.1391
Shoulder	-0.4746	-0.9898	0.7068
Peak	-0.0573	0.5772	-1.221
2) Relative Prices:			
U.S	-0.7236	-4.0265	-3.1107
U.K	2.6597	-0.0579	2.1983
3) Income:	-1.0882	0.2845	-0.20

(A) For calculations of the shoulder and peak travel period elasticities see Appendix F.1.

Econometric models with large numbers of independent variables tend to be plagued with collinearity problems. The model specified here has 30 independent variables. The liberal usage of interaction terms would also increase the collinearity problems.

The single equation estimation, besides estimating the own price and cross price elasticities, was used to test for serial correlation The test for serial correlation may be accomplished by observing the plots of the residual and/or the Durbin-Watson statistic. The plot of the residuals should show no consistent pattern; if for example a series of negative followed by a series of positive values occurs serial correlation may be a problem. Generally if the Durbin-Watson statistic ranges from 1.6 to 2.5, it is acceptable.

The Durbin-Watson statistic for equations 2 and 3 is 1.584, suggesting an unacceptable level of serial correlation. Three possible corrections are available. The first method is to add more variables to the model, as the disturbance term may represent the actions of variables previously omitted.[6] The second approach suggests transforming the data to first differences.[7] The final approach is to use the Cochrane-Orcutt correction for serial correlation. Generally, econometricians feel that the use of the Cochrane-Orcutt transformation should be a last resort.

Through exhaustive research in the literature, no other variables seemed likely to contribute to the model. A lagging process was not tried, because with the present size of the model a lagging process could lead to further complications: the use of a distributed lag process would increase the number of explanatory variables in the model.

The first differences approach to solving the serial correlation problem was not tried. The concept of first differences transformation requires that the difference between the observation in period t and the immediately preceding observation (period t-1) be estimated. For the study this process was not possible. For example, an observation in July, is a shoulder period observation, the immediately preceding observation (June) belongs to the peak travel season. Thus, what the transformed data will be estimating is not clear. Because of these difficulties the Cochrane-Orcutt correction for serial correlation was used.

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6. M.D. Intriligator, *Econometric Models, Techniques and Applications*, 1978, p. 164.

7. Intriligator and Kmenta take opposing views to this first difference approach. Intriligator suggests that it may solve the serial correlation problem, while Kmenta states that it may worsen the problem.

Before presenting the results of equations 2 and 3 that were estimated with the Cochrane-Orcutt transformation, the correlation problem should be explained. The classical normal linear regression model assumes that none of the explanatory variables be perfectly correlated with any other explanatory variable or with any linear combination of other explanatory variables.[8] A high degree of correlation among the independent variables is harmful in the sense that the estimates of the regression coefficients are highly imprecise (i.e. large variances).[9] The correlation among independent variables is a sample problem; the sample does not provide "rich" enough information on the explanatory variables to meet the requirements of the model.[10]

In equation 2 in Table 6.1 there is a high degree of correlation among the fare variables, that is LNLF, LNSF and LNPF. The correlation coefficient for the shoulder fare with respect to the low fare is 0.916, for the peak fare to the low fare it is 0.754 and for the peak to the shoulder fare it is 0.693. The shoulder fare interaction terms: D_SLNLF, D_SLNSF, D_SLNPF show a high degree of correlation between each other, mostly to 0.99. The peak interaction fares also exhibit the same high degree of correlation. The relative prices variables and income variables are highly correlated with their respective travel periods. For example, the shoulder U.S., U.K. relative prices and income are highly correlated with the shoulder fare interaction terms.[11] Thus the generation and use of the interaction

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8. J. Kmenta, *Elements of Econometrics,* 1971, p. 380.
9. *Ibid.,* p. 389.
10. M.D. Intriligator, *Econometric Models, Techniques and Applications,* 1978, p. 153.
11. The correlation matrix for equation 2 and 3 are presented in Appendix G.1 and G.2 respectively.

terms seems to increase the correlation problem. The same problem can be seen in the correlation matrix for equation 3, that is the highest degree of correlation is between the interaction terms with each travel period.

One approach to the problem is to augment the sample with additional data.[12] That is by increasing the number of observations or by adding on more explanatory variables to the model.

A second approach is to scale down the model to the data available.[13] This would result in a change in the specification of the model by dropping some of the explanatory variables or to average or aggregate certain groups of variables.

The final approach is simply to recognise the existence of the correlation problems and not to try to change the data or the model.[14] If the model as specified is based on a well-developed underlying theory, then there is no justification for changing the specification. By changing the specification, it could induce specification errors, creating biases in all of the estimated coefficients. A high degree of correlation among independent variables would result in large variances being associated with the estimated coefficients. Thus the acceptance region for the hypothesis that a given regression coefficient is zero will be wide. This is all that can be said about the significance of the estimated coefficients.[15] Thus there is very little justification for tampering with the data or the model specification. It is for this last reason that the entire model will be retained and re-estimated using the Cochrane-Orcutt correction for serial correlation.

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12. M.D. Intriligator, *Econometric Models, Techniques and Applications*, p. 153.

13. *Ibid.*, p. 154.

14. *Ibid.*, p. 155.

15. *Ibid.*, p. 155.

A. RESULTS OF THE COCHRANE-ORCUTT TRANSFORMATION

Due to the lack of additional data and variables, the Cochrane-Orcutt transformation was applied to equations 2 and 3. The dependent variable is the log of leisure travellers travelling from Australia to the U.S.A. per capita. The results are presented in Table 6.1.1.

TABLE 6.1.1

Estimated Coefficients for Equations 2 and 3 using the Cohrane-Orcutt Transformation

Equation Number	2.1 Corresponds to Equation 2	3.1 Corresponds to Equation 3
Independent Variables		
DJ	-12.2765 (-1.4784)	-12.2765 (-1.4784)
DF	7.3378 (0.6564)	7.3378 (0.6564)
DM	7.6607 (0.6888)	7.6607 (6.888)
DA	-12.0588 (-1.4662)	-12.0588 (-1.4662)
DMY	-3.1491 (-0.3968)	-3.1491 (-0.3468)
DJN	-3.4605 (-0.4365)	-3.4605 (-0.4365)
DJL	-11.7818 (-1.4346)	-11.7818 (-1.4346)
DAG	-3.1505 (-0.3959)	-3.1505 (-0.3959)
DST	-12.0122 (-1.4585)	-12.0122 (-1.4585)
DOC	7.7465 (0.6902)	7.7465 (0.6902)
DNU	7.5352 (0.6686)	7.5352 (0.6686)
DDC	-3.0732 (-0.3793)	-3.0732 (-0.3793)

contd.

TABLE 6.1.1 (contd)

Equation Number		2.1 Corresponds to Equation 2	3.1 Corresponds to Equation 3
Independent Variables:			
In Equation 2.1	In Equation 3.1		
LNLF	DLLNLF	-0.8351 (-3.0235)	-0.8351 (-3.0235)
LNSF	DLLNSF	-0.5633 (-1.2149)	-0.5633 (-1.2149)
LNPF	DLLNPF	-0.3216 (-0.3542)	-0.3216 (-0.3542)
DSLNLF	DSLNLF	0.7556 (1.9123)	0.0795 (0.2419)
DSLNSF	DSLNSF	-0.3943 (-0.6343)	-0.9575 (-1.9629)
DSLNPF	DSLNPF	1.2093 (0.8347)	0.8877 (0.7231)
DPLNLF	DPLNLF	0.8189 (2.2374)	-0.0162 (-0.0623)
DPLNSF	DPLNSF	1.1953 (1.8052)	0.6319 (1.3323)
DPLNPF	DPLNPF	-1.1215 (-0.9556)	-1.4431 (-1.7282)
LNAXUS	DLAXUS	-0.5575 (-0.7679)	-0.5575 (-0.7679)
DSAXUS	DSAXUS	-3.84 (-2.8516)	-4.3976 (-3.5726)
DPAXUS	DPAXUS	-2.4038 (-2.8674)	-2.9613 (-5.9174)
LNAXUK	DLAXUK	2.6473 (4.0571)	2.6473 (4.0571)
DSAXUK	DSAXUK	-2.8864 (-2.3391)	-0.2392 (-0.2126)
DPAXUK	DPAXUK	-0.171 (-0.1677)	2.4763 (3.1392)
LNRDYM	DLRYM	-0.9749 (-0.7631)	-0.9749 (-0.7631)
DSRDYM	DSRDYM	1.6153 (1.7385)	0.6403 (1.0065)
DPRDYM	DPRDYM	0.9115 (0.5611)	-0.0634 (-0.0602)
RHO	RHO	0.2624 (2.4771)	0.2624 (2.4771)

contd.

TABLE 6.1.1 (contd)

	2.1 Corresponds to Eq.2	3.1 Corresponds to Eq.3
R^2	0.9469	0.9469
D.F.	53	53
D.W.	2.13	2.13

The effect of the Cochrane-Orcutt transformation was to improve the Durbin-Watson statistic. The Durbin-Watson statistic without the Cochrane-Orcutt transformation was 1.55, it has improved to 2.13: thus eliminating the problem of serial correlation. The assumption that the disturbance terms are independent of each other now holds, therefore any biases have been eliminated. The elasticities from equation 2.1 are shown in Table 6.1.2.

TABLE 6.1.2

Computed Elasticities from equation 2.1 after applying the Cochrane-Orcutt transformation

Travel Period		Low	Shoulder	Peak
Variables:				
1) Fare -				
	Low	-0.8351	0.0795	-0.0162
	Shoulder	-0.5633	-0.9576	0.6320
	Peak	-0.3216	0.8897	-1.4431
2) Relative Prices -				
	U.S.	-0.5575	-4.3975	-2.9613
	U.K.	2.6473	-0.2391	2.4763
3) Income -		-0.9749	0.6404	-0.0634

The elasticities presented by equation 2.1 are identical to the estimated coefficients from equation 3.1.

Having identified and treated the serial correlation problem and having recognised that there is a high degree of correlation among the independent variables, no further econometric estimation was attempted. The removal of variables carrying the wrong signs or variables that are insignificant may lead to specification errors and to further complications. The cure may be worse than the disease. The high degree of correlation among independent variables means that the variances are large, but it does not show that the estimates are biased in any way. The aim of this study was to estimate the cross relationships between travel seasons. The econometric model has shown only two cross elasticities to be acceptable; while the own price elasticity would appear to be rather low. By setting up a demand elasticity matrix and using only those estimated elasticities that are plausible, it is possible to infer the missing elasticities. The missing elasticities may be inferred by constraining the demand system to satisfy the known conditions applying to elasticities in the system (see Chapter 7).

It should be noted that the cross elasticities generated by the double log function are due to the large change in fares in 1979: the seasonal fares were introduced from that period onwards. The effect of introducing seasonal fares in 1979 was to change the shares in each travel period. How these shares have changed can be seen in Table 6.1.3.

TABLE 6.1.3.

Travel Period shares before and after 1979

Travel Season	Number of Leisure travellers before 1979	% share	Number of Leisure travellers after 1979	% share
Low	48,920	19.71	59,784	32.04
Shoulder	80,190	32.31	55,265	29.68
Peak	119,096	47.98	71,530	38.34
Total	248,206	100.00	186,579	100.00

The double log form ensures constant elasticity throughout the period under observation. These changes in travel shares raise serious doubts about the applicability of the functional form on the data.

A better approach to the problem would have been to use a flexible functional form; such as the translog, and to constrain the price elasticities to meet the conditions known to exist in a demand system (i.e. homogeneity and symmetry). However, it may be more difficult to specify the model presented here in a translog functional form. For instance, the monthly dummies required to estimate the effect of seasonality and end effects would be difficult to specify in a translog.*

Throughout the literature on airline demand function, very few authors have been able to estimate any cross elasticities. The recent success in estimating cross elasticities has been through the use of flexible functional forms. If this model were to be specified in the translog form, even without the monthly dummies, the number of independent variables would be quite large due to the cross product requirement of the translog.

The present state of research in the airline industry has only gone as far as estimating cross relationships between fareclasses. This study is the first attempt at estimating the cross relationship between travel seasons.

All the problems involved with the estimation of seasonal demand curves have been mentioned. Attempts have been made to correct the problems and failing that the problems have been recognised.

The own price elasticities of each travel period appear to be low.

* In my search of the translog literature, I have not come across any studies that have used dummies in their model specifications.

Previous studies on leisure travel suggest the own price elasticity to be at least -1.0 and some estimates are as high as -2.0.[16] The own price elasticity in the low period of -0.84 suggests that if the fare were increased by 1% a reduction in the number of leisure travellers in the low period of -0.84 would occur, assuming all other variables are held constant. Using the same assumption if the fare were increased by 1% in the shoulder and peak period, leisure travel would decrease by 0.96% and 1.44% respectively.

The only cross price elasticity estimates that appear plausible are the cross price elasticity of the shoulder period with respect to the peak fare (0.89), and the cross price elasticity of the peak period with respect to the shoulder fare (0.63). The other cross price elasticities carry negative signs; as it is hard to believe that trips in different periods are complements they cannot be regarded as plausible.

The U.S. relative prices may be considered an attraction measure, but more accurately it reflects the cost of living in the U.S. relative to Australia. As a destination becomes more expensive one would expect a price sensitive leisure traveller to either bypass the destination or spend less time there. In the model the variable is quite important, the t statistics in equation 3.1 show that it is significant and it carried the expected sign. Thus in the low period if the U.S. relative price increases by 1% it would lead to a reduction in leisure travellers of 0.56%.. In the shoulder period, the 1% increase would reduce leisure travellers by 4.4% and in the peak by 2.96%.

The U.K. relative price is a similar measure to the U.S. relative

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16. See Chapter 4 on "Demand Studies".

price. In this study, the U.K. is considered to be a substitute destination. The U.K. relative price variable was expected to carry a positive sign: the shoulder period U.K. relative price is negative and non significant. For the other two periods however, the coefficient is significant. The effect of increasing the U.K. relative price by 1% would be to increase leisure travel to the U.S. in the low period by 2.65% and in the peak by 2.48%.

The income variable was expected to be positively related to leisure trips per head at all income levels. However in the low and peak periods the coefficients are negative and in all periods they are non-significant.

The estimated elasticities that are considered to be plausible will be used to synthesize a demand elasticity matrix for all travel periods. The missing values will be generated from the conditions applying to elasticities in that demand system.

CHAPTER 7.

A COHERENCE APPROACH TO ESTIMATING THE PRICE ELASTICITIES FOR THE DEMAND FOR LEISURE TRAVEL BY TRAVEL SEASONS.

In the previous chapter an attempt was made to estimate the price elasticities associated with the travel seasons available on the Australia-U.S.A. air route. The ordinary least squares estimation technique was applied to the demand equation in the double log form. The model failed to provide plausible estimates for the cross price elasticities of demand for travel in the low period with respect to the shoulder and peak fares. Other implausible estimates were the U.S. relative prices in the low period (the estimated coefficient appeared to be a bit low), the U.K. relative prices in the shoulder period (it had a negative sign), and the estimated income elasticities were all insignificant, carried the wrong sign or were too small to be plausible. To arrive at some sort of estimate of the coefficients, the coherence approach was adopted to synthesize the missing demand elasticities.

The coherence approach applies the conditions known to exist in a demand system to generate the missing elasticities. To some extent this approach is arbitrary, it requires some judgement to be made by the researchers as to the plausibility of the estimated elasticities. In some cases it requires the researcher to make guesses at the missing elasticity, which would be adjusted after applying the rest of the conditions known to exist in a demand system. Once the estimated elasticities are found to conform to all the conditions, they may still be subject to certain biases as the nature of this approach requires the researcher to apply his own judgement as to where to start and what values are acceptable. Thus other values might be found that would satisfy the demand system conditions.

Only the plausible estimates from the single equation were used to set up the original matrix. This step itself can cause some problems. The major problem relates to the estimation technique itself; a log linear model was used. The log linear model assumes constant elasticities for that time period. This can only be true over a very short range; in general, if price, income and budget shares vary, so would the elasticities.[1] To assume constant elasticities for the period January 1974 to December 1980, may be unrealistic.

The reliability of the synthesized matrix may be questionable and at the very best the elasticities approximate values. However, cross elasticities in the leisure travel market are important as the potential consumers tend to shop around and assess each travel alternative on its merits. Therefore the cross elasticities of demand between competing forms of vacation travel may be large: this implies that pricing decisions made by airline operators may be handicapped if these cross elasticities are not taken into account.[2]

A. THE SYNTHESIZED MATRIX OF ELASTICITIES OF DEMAND FOR LEISURE TRAVEL

Four conditions are used to synthesize the demand matrix:[3]

(1) Homogeneity - the price, cross price and income elasticities sum to zero in each demand equation.

(2) Symmetry - if E_{ij} is the cross price elasticity of demand for i with respect to j and E_{ji} is similarly defined, then

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1. A. Brown & A. Deaton, "Surveys in Applied Econometrics: Models of Consumer Behaviour", *Economic Journal* 82(1972), p. 1151.

2. J.H.E. Taplin, "A Coherence Approach to Estimates of Price Elasticities in the Vacation Travel Market", *Journal of Transport Economics and Policy*, Jan. 1980, p. 19.

3. J.H.E. Taplin, "A Coherence Approach", *J.T.E.P.*, Jan.1980, p.20.

$$E_{ij} = (R_j/R_i)\, E_{ji} + R_j\, (E_{jy} - E_{iy})$$

where R_j, R_i are properties of total expenditure and

E_{iy}, E_{jy} are income elasticities of demand.

Because vacation travel is a small part of the total expenditure the second term is negligible in magnitude and thus the first term alone can be used.

(3) Cournot Column Aggregation $\sum_i R_i E_{ij} = -R_j$

(4) Engel Aggregation $\sum_i R_i E_{iy} = 1.$

The synthesized demand matrix requires an estimation of the expenditure shares for each travel season. The share of expenditure for overseas vacation air trips is 1.114% of the total household expenditure.[5] The share of the U.S. route was derived from the share of expenditure for all overseas vacation air trips; it was then apportioned to each travel season.[6] The first synthesized matrix (Table 7.1) utilises all the plausible estimates from Table 6.1.2. Two cross elasticities were estimated, the cross price elasticity of the demand for travel in the shoulder period with respect to the peak fare and the cross elasticity of the demand for travel in the peak period with respect to the shoulder fare (0.89 and 0.63 respectively). These two elasticities do not meet the symmetry condition. If the peak season cross price elasticity with respect to the shoulder fare were used, by symmetry the cross price elasticity with respect to the peak fare in the shoulder season should be 1.1. If the shoulder season cross price elasticity with respect to the peak fare were used, the cross price elasticity with respect to the shoulder fare in the

5. *Ibid.*, p.24.

6. See Appendix H. for the calculation of the expenditure shares.

peak season should be 0.53. An average was taken of the two values to yield a cross elasticity with respect to the peak fare in the shoulder season of 0.99 and the cross price elasticity of the peak season demand with respect to the shoulder fare of 0.58. These two values were then placed in the synthesized demand matrix shown in Table 7.1.

The single equation did not generate any income elasticities that were considered to be plausible. To make the demand system complete, some income elasticity had to be assumed.

TABLE 7.1

The starting framework of the synthesized matrix of demand elasticities for leisure travel in the three travel seasons.

	Elasticity of demand with respect to:							
Demand for	Low Fare	Shoulder Fare	Peak Fare	Relative Prices- U.S.	Relative Prices- U.K.	Income	Other Goods & services	% share expenditure
1) Travel in the Low Season	-0.84			-0.56	2.65			0.0475
2) Travel in the Shoulder Season		-0.95	0.99	-4.4				0.0658
3) Travel in the Peak Season		0.58	-1.44	-2.96	2.48			0.11138

Other studies on airline demand functions have shown the income elasticity to vary between 1.1 and 3.3.[7] Taplin estimated an income elasticity for overseas holiday air fares to be 1.5, this value will be used to approximate the income elasticities for all travel seasons.[8] If the assumed income elasticity were much larger than 1.5, some of the

7. See Chapter 4 on "Demand Studies".
8. J.H.E. Taplin, "A Coherence Approach", *J.T.E.P.*, Jan. 1980, p.22.

cross elasticities may carry a negative sign, which is implausible. In the shoulder season equation in the U.K. relative price elasticity is missing. Since the shoulder period is an intermediate travel season, an average was taken of the U.K. relative price elasticities for the low and peak travel seasons: this gives the U.K. relative price elasticity in the shoulder period a value of 2.57. Through the homogeneity condition, the cross price elasticity of demand for travel in the shoulder period with respect to the low fare can be imputed and has a value of 0.3. This is based on an initial assumption that the cross price elasticity with respect to other goods and services is negligible, which may be quite reasonable. Taplin estimated the cross price elasticity of the demand for vacation air trips overseas with respect to prices of other goods and services to be negligible.[9] By symmetry, the cross price elasticity of the demand for travel in the low season with respect to the shoulder fare may be imputed: this has the value of 0.4. The synthesized matrix of the demand elasticities now takes the following shape:

TABLE 7.2

The second stage of the synthesized matrix of demand elasticities for leisure travel in the three travel seasons.

	Elasticity of demand with respect to:							
Demand for	Low fare	Shoulder Fare	Peak Fare	Relative U.S.	Prices U.K.	Income	Other goods & services	% share expenditure
1) Travel in the Low Season	-0.84	0.4^{S}		-0.56	2.65	1.5*		0.0475
2) Travel in the Shoulder Season	0.3^{H}	-0.96	0.99	-4.4	2.57	1.5*	0.0	0.0658
3) Travel in the Peak Season		0.58	-1.44	-2.96	2.48			0.1113

S - By Symmetry; H - By Homogeneity; * Assumed values

9. *Ibid.*, p.24.

At this stage it is possible to ascertain whether the assumption of zero for the cross price elasticity with respect to the price of other goods and services in the shoulder season holds. The Cournot Column Aggregation is used to test this assumption; the result shows that that cross elasticity is -1.31,[10] which is implausible as there should be more substitutes than complementary goods, thus the cross price elasticity should be positive and small.[11] By applying the Cournot Aggregation condition in columns 1, 2 and 3, it is possible to find out by how much the own price elasticity would have to be increased for the assumption of a small cross price elasticity with respect to other goods and services to hold.[12] This assumes that the cross price elasticities with respect to other fares in the shoulder season are fixed. After a series of tests, the own price elasticity in the shoulder period was found to be -2.3 for the assumption of a negligible cross price elasticity with respect to other goods and services to hold. The third stage synthesized matrix is presented in Table 7.3.

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10. See Appendix H.1 for calculation of the cross price elasticity of demand for travel in the shoulder period with respect to prices of other goods and services.

11. See Prais and Howthakker, *The Analysis of Family Budgets* (Cambridge University Press: London), p. 16.

12. For the calculation of the own price elasticities see Appendix H.2.

TABLE 7.3

The third stage of the synthesized matrix of demand elasticities for leisure travel in the three travel seasons.

Elasticity of demand with respect to:

Demand for	Low Fare	Shoulder Fare	Peak Fare	Relative U.S.	Price U.K.	Income	Other goods & services	% share expenditure
1) Travel in the Low Season	-0.84	0.4^{S}		-0.56	2.65	1.5		0.0475
2) Travel in the Shoulder Season	0.3^{H}	-2.3	0.99	-4.4	3.88	1.5	0.03	0.0658
3) Travel in the Peak Season		0.58	-1.44	-2.96	2.48			0.11138

After applying the Cournot Column Aggregation condition, an adjustment had to be made to the price elasticities for homogeneity to hold. This resulted in increasing the U.K. relative prices from 2.57 to 3.88.

The next stage is to estimate the value of the cross price elasticity of demand for travel in the peak season with respect to the low fare. To maintain an income elasticity of 1.5 for the peak equation would give an implausible estimate of the missing cross price elasticity (it would be -0.17). It is likely that the income elasticity in the peak period would be less than in the other two seasons as the fares in the peak season are higher, implying peak season travellers are less income elastic. A value of 1.0 was chosen for peak season travellers (it is unlikely that this income elasticity would be less than 1.0 as no other study has obtained values of income elasticity below

1.0). By applying the homogeneity condition, the missing value for the cross price elasticity in the peak season equation is imputed to be 0.34. This figure is supported by Oum and Gillen's work on inter-fareclass competition in which the cross price elasticity of demand for economy class travel with respect to the high discount fare was in the range of 0.28 to 0.45. By symmetry, the cross price elasticity of demand for travel in the low season with respect to the peak fare may be imputed and has the value of 0.79. Applying the Cournot Column Aggregation condition the own price elasticities may be adjusted so that the assumption of a negligible cross price elasticity with respect to other goods and services will hold. This calculation shows the own price elasticity in the low period to be -2.2 and in the peak period -2.0. A series of adjustment is required for the demand system to conform to the homogeneity condition. In the case of the low equation, the U.S. relative price is adjusted upwards from -0.56 to -3.12 and in the peak equation the income elasticity is increased to 1.49. The U.S. relative price in the low equation was chosen for adjustment, as it was felt that this estimate was a bit low. The income elasticity was adjusted in the peak equation because the original income elasticity was an assumed value and it is desirable to incorporate as many of the estimated elasticities from the regression equation as possible. The final synthesized demand matrix is in Table 7.4.

By looking at the final synthesized matrix of demand elasticities, it can be seen that not many of the elasticities estimated from the single equation remain. The two most restrictive assumptions that have been imposed in the above analysis concern the values of the income elasticity and the cross price elasticity with respect to other goods and services (close to zero). If the income elasticity value

TABLE 7.4

The final synthesized matrix of demand elasticities for leisure travel in the three travel seasons.

Demand for	Elasticity of demand with respect to: Low Fare	Shoulder Fare	Peak Fare	Relative U.S.	Prices U.K.	Income	Other goods & services	% share expenditure
1) Travel in the Low Season	-2.2	0.4	0.79	-3.12	2.65	1.5	0.01	0.0475
2) Travel in the Shoulder Season	0.3	-2.3	0.99	-4.4	3.88	1.5	0.03	0.0658
3) Travel in the Peak Season	0.34	0.58	-2.0	-2.96	2.48	1.49	0.08	0.11138

is allowed to change the imputed cross elasticities would change and so would the own price elasticities. There is a limit to the possible variation on the income elasticity, if it were much greater than 1.5 no plausible cross price elasticities could be estimated; an income elasticity below one is unacceptable. Some sensitivity tests are carried out in the next section.

B. SENSITIVITY TESTS - USING AN INCOME ELASTICITY OF ONE

By allowing the income elasticity to drop to one some cross price elasticities and own price elasticities may change. The initial matrix is presented in Table 7.B.1.

TABLE 7.B.1.

The initial synthesized matrix of demand elasticities for leisure travellers in the three travel seasons using an income elasticity of 1.0.

Demand for	Low Fare	Shoulder Fare	Peak Fare	Relative U.S.	Prices U.K.	Income	Other goods & services	% share expenditure
	Elasticity of demand with respect to:							
1) Travel in the Low Season	-0.84	1.1^S	0.77^S	-0.56	2.65	1.0*	-4.12^H	0.0475
2) Travel in the Shoulder Season	0.8^H	-0.96	0.99	-4.4	2.57	1.0*	0^H	0.0685
3) Travel in the Peak Season	0.34^H	0.58	-1.44	-2.96	2.48	1.0*	0^H	0.1113[illegible]

H - by Homogeneity; S - by Symmetry; * assumed values

The missing cross elasticities, E_{21} and E_{31} are imputed first by homogeneity, then symmetry is applied to obtain the cross elasticities, E_{12} and E_{13}. The U.K. relative price elasticity in the shoulder season is the same as the previous section. Through homogeneity the cross price elasticities with respect to other goods and services are imputed. The element in E_{17} (-4.12) is implausible and the Cournot Column Aggregation is used to adjust all the cross price elasticities in column 7. By this method new own price elasticities are obtained. A residual value then occurs: for the low equation it is -2.08, for the shoulder equation 1.82 and for the peak 0.49. For the low equation the residual is allocated to the U.S. relative price, for the shoulder it is allocated to the U.K. relative price and for the peak the residual value is added to the income elasticity. The final matrix is presented in Table 7.B.2.

TABLE 7.B.2.

The final synthesized matrix of demand elasticities for leisure travellers in the three travel seasons using an income elasticity of 1.0.

	Elasticity of demand with respect to:							
Demand for	Low Fare	Shoulder Fare	Peak Fare	Relative U.S.	Prices U.K.	Income	Other goods & services	% share expenditure
1) Travel in the Low Season	-2.9	1.1	0.77	-2.64	2.65	1.0	0.02	0.0475
2) Travel in the Shoulder Season	0.8	-2.8	0.99	-4.4	4.39	1.0	0.02	0.0658
3) Travel in the Peak Season	0.33	0.58	-2.0	-2.96	2.48	1.49	0.08	0.11138

The income elasticity in the peak period was used to adjust the equation to comply with the homogeneity condition for two reasons. The residual value 0.49 could have been allocated in part to either the cross price elasticities with respect to low and shoulder fares or the relative price elasticities. However, an allocation of the residual to the cross price elasticity of the fares would be arbitrary and it would necessitate a re-calculation of the own price elasticities for the Cournot Column Aggregation condition to hold. If the residual values were allocated to the relative price variable, this would mean a rejection of the estimated elasticities from the single equation which were highly significant. The point of this exercise was to merge the estimated elasticities from the regression equation which were significant and plausible with imputed elasticities from the coherence approach. Thus in all equations it is desirable to hold on to as many of the elasticities estimated from the single equation as possible.

In the initial synthetic matrix the plausible range for the income elasticity is between 1.0 and 1.5, depending on which value is taken the own price and cross price elasticities in the shoulder and low equations will vary. Once the cross price elasticities have been imputed (through the homogeneity and symmetry conditions) they are held as fixed values to impute the own price elasticities subject to the Cournot Aggregation.

The own price elasticities imputed from the conditions placed on the matrix of demand elasticities look plausible. The original own price elasticities estimated by the single equation were quite small. Other studies on leisure travel have estimated the own price elasticity to be around -1.7 to -2.0.[13] Thus the higher own price elasticities look more plausible.

The relative price elasticities also look plausible. Artus estimated the average elasticity for local currency prices in Europe to be -2.71 and for foreign exchange it was -3.58.[14] Jud and Joseph estimated the relative price elasticities for U.S. travel to Latin America to be -1.8.[15] Thus generally, the relative price elasticities have been large and significant.

The elasticities in the synthesized matrix of demand elasticities look plausible. They are however only approximations.

C. NET EFFECTS

The importance of estimating cross elasticities in the leisure travel market can be seen in the effects these cross elasticities have

13. See Chapter 4 on "Demand Studies" - Smith and Toms, and Oum and Gillen's results.
14. J. Artus, "An econometric Analysis of International Travel", *I.M.F. Staff Papers*, Vol.19 (1972), p. 591.
15. Jud & Joseph, "International Demand for Latin American Tours", *Growth and Change*, Jan. 1974, p. 29.

on different pricing policies. As leisure travellers are price sensitive, any changes in the fares would lead to an almost immediate response on the part of the traveller's behaviour. Only institutional factors and some psychological factors may lead to a reduction in the potential response.

If the policy maker based his pricing decisions on the own price elasticity alone his estimates of the patronage level may be inaccurate and lead to the provision of excess capacity. To see how these cross elasticities affect the patronage levels, four cases are examined using the elasticities generated in Tables 7.4 and 7.B.2 The results are in Tables 7.2.1 and 7.2.4.

TABLE 7.2.1

Reduce all prices by 1%, taking effect simultaneously.

	Elasticities from Table:					
	7.4			7.B.2.		
	Low	Shoulder	Peak	Low	Shoulder	Peak
The effect of reducing the low fare by 1%	+2.2	-0.3	-0.34	+2.9	-0.8	-0.34
The effect of reducing the shoulder fare by 1%	-0.4	+2.3	-0.58	-1.1	+2.8	-0.58
The effect of reducing the peak fare by 1%	-0.77	-0.99	+2.0	-0.77	-0.99	+2.0
% change in travellers: NET EFFECT	1.03	1.01	1.08	1.03	1.01	1.08

Both of the imputed elasticities from Tables 7.4 and 7.B.2 yield the same net effects, because the same restrictions have been applied. All the shares are still the same; thus through symmetry and the

Cournot Aggregation similar results are obtained.

The net effects in Table 7.2.1 indicate that the aggregate elasticity is about -1.0. By summing the fare elasticities for the low, shoulder and peak periods and taking the average, the aggregate elasticity is -1.04. This elasticity is lower than estimates made by other researchers into leisure travel. The Smith and Toms estimate for Australian travellers to the U.S. was -1.67, however, they did not include a relative price variable which could lead to a higher estimate on the fare elasticity. The time periods between Smith and Toms' work and the study are different; this could account for the different results.

TABLE 7.2.2.

The effect of increasing the low fare by 1% while decreasing the peak and shoulder fares by 1% simultaneously.

	Elasticities from Table:					
	7.4			7.B.2		
	Low	Shoulder	Peak	Low	Shoulder	Peak
The effect of increasing the low fare by 1%	-2.2	+0.3	+0.34	-2.9	+0.8	+0.34
The effect of decreasing the shoulder fare by 1%	-0.4	+2.3	-0.58	-1.1	+2.8	-0.58
The effect of decreasing the peak fare by 1%	-0.77	-0.99	+2.0	-0.77	-0.99	+2.0
NET EFFECT	-3.37	1.61	1.76	-4.77	2.61	1.76

If the policy maker decided to pursue the pricing policy shown in Table 7.2.2, the patronage level in the low period would decrease by more than the own price elasticity suggests and the patronage levels in the other two periods would not increase by as much. This is due to the effects of the cross elasticities of demand.

TABLE 7.2.3

The effect of increasing the shoulder fare by 1% while decreasing the peak and low fares by 1% simultaneously.

	Elasticities from Table:					
	7.4			7.B.2		
	Low	Shoulder	Peak	Low	Shoulder	Peak
The effect of decreasing the low fare by 1%	+2.2	-0.3	-0.34	+2.9	-0.8	-0.34
The effect of increasing the shoulder fare by 1%	+0.4	-2.3	+0.58	+1.1	-2.8	+0.58
The effect of decreasing the peak fare by 1%	-0.77	-0.99	+2.0	-0.77	-0.99	+2.0
NET EFFECT	1.82	-3.59	2.24	3.23	-4.59	2.24

TABLE 7.2.4

The effect of increasing the peak fare by 1% while decreasing the shoulder and low fares by 1% simultaneously.

	Elasticities from Table:					
	7.4			7.B.2		
	Low	Shoulder	Peak	Low	Shoulder	Peak
The effect of decreasing the low fare by 1%	+2.2	-0.3	-0.34	+2.9	-0.8	-0.34
The effect of decreasing the shoulder fare by 1%	-04	+2.3	-0.58	-1.1	+2.8	-0.58
The effect of increasing the peak fare by 1%	+0.77	+0.99	-2.0	+0.77	+0.99	-2.0
NET EFFECT	2.57	2.99	-2.92	2.57	2.99	-2.92

In the case of a uniform change across every travel season, the season with the highest own price elasticity would experience a smaller percentage response. This result is based on the symmetry condition given the expenditure shares and as long as the cross elasticities are of some significant magnitude.[16] The effect indicates the importance of cross elasticities to pricing policies; thus even an imperfect estimate of the size of the cross elasticity may be better than no estimate.

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11. J.H.E. Taplin, "A Coherence Approach", *J.T.E.P.*, Jan. 1980, p. 28.

CHAPTER 8.

PEAK LOAD PRICING ON THE AUSTRALIA-U.S.A. AIR ROUTE.

One of the major problems in the field of transport is the variability of demand over time while the supply is fixed. The airline provides a service, that is getting a traveller from point A to point B; the supply cannot be stored. Thus in periods of excess demand it is not possible in the short run to increase the capacity supplied. In the short run the capacity provided on the Australia-U.S.A air route is fixed while there is variability in demand between travel seasons, so that using a uniform fare (as the operators were before 1979) caused significant differences in the capacity utilisation rates over the year.

In 1979 operators made an attempt to stabilise the level of demand, that is to remove the peaks and troughs. This was done by adopting a set of seasonal fares with the highest APEF fare in the peak period and the lowest APEF fare in the low period. Generally, the overall operating level set by the operators is determined by the peak demand; those passengers who demand air services during the peak should bear the costs of system (marginal) capacity costs. At the same time they would also have to bear the operating cost of the aircraft in that period. While the off-peak traveller would only need to pay for the operating costs.

The pricing principle for peak and off-peak use is clear. A justification for this pricing principle can be seen in Dr. C.A. Cannon's comments to the Domestic Air Transport Policy Review:

"Such temporal fare differences encourage efficient

> use of airline resources and improves total passenger welfare. In addition, since peak/off-peak pricing establishes an efficient basis for the registration and adjustment of demand, it thereby provides a rational economic basis for investment planning and determination of total airline capacity."[1]

Since the present capacity is set to meet the demand for travel in the peak season, the operator would like to increase the demand in the off-peak to match peak demand. The peak fares charged should be related with the long run costs by varying the fares between travel seasons it is possible for the operators to attain this ideal situation.

Since the introduction of seasonal fares by airline operators in 1979, the share of leisure travellers in each season has tended to level off (see Table 6.1.3, page 61). However, there is still a significant variation between the peak and low travel seasons. Using the imputed elasticities from the previous chapters, it is possible to calculate a fare for each season that would further reduce this variation in demand for travel between seasons.

The short run and long run marginal costs are then estimated. If the optimum fares are to be operational then the low fare should cover operating costs (S.R.M.C.) and the peak fare should at least cover capacity plus operating costs (L.R.M.C.).

A. CALCULATION OF THE OPTIMUM FARES:

The fare elasticities in Table 7.4 are used to derive the optimal fares for each travel season. The theoretical treatment of peak load pricing (see Chapter 2) assumed the demand in each period was

1. C.A. Cannon, "Pricing of Domestic Airline Services - Selected Aspects of Fare on Australia's Competitive Routes", from The Domestic Air Transport Policy Review (Canberra, A.G.P.S., 1979,), Vol. II, p. 113.

independent of the demand in other periods. The existence of cross elasticities between travel seasons shows that the demand in one season is dependent on the demand for travel in other seasons. The interdependency of demand for travel between seasons requires that the solution be solved for simultaneously; thereby taking into account the cross elasticities. The three demand equations are:

$$\text{(Eq.1)} \quad \ln X_L = \ln a_L - 2.2 \ln(\text{low fare}) + 0.4 \ln(\text{shoulder fare}) + 0.77 \ln(\text{peak fare})$$

$$\text{(Eq.2)} \quad \ln X_S = \ln a_S + 3.0 \ln(\text{low fare}) + 2.4 \ln(\text{shoulder fare}) + 0.99 \ln(\text{peak fare})$$

$$\text{(Eq.3)} \quad \ln X_P = \ln a_P + 0.34 \ln(\text{low fare}) + 0.58 \ln(\text{shoulder fare}) - 2.0 \ln(\text{Peak fare})$$

where

		Travellers
$\ln X_L$ =	the log of the number of travellers in the low period,	6,305
$\ln X_S$ =	the log of the number of travellers in the shoulder period,	6,332
$\ln X_P$ =	the log of the number of travellers in the peak period,	10,545

Low fare : \$239.23, in 1970 dollars,

Shoulder fare : \$338.85, in 1970 dollars,

Peak fare " \$455.72, in 1970 dollars,

$\ln a_L$ = the log of the prices of all other goods and services in the low season,

$\ln a_S$ = the log of the prices of all other goods and services in the shoulder season.

$\ln a_P$ = the log of the prices of all other goods and services in the peak season.

The calculated values of the $\ln a_i$'s were:[2]

$$\ln a_L = 13.7551$$
$$\ln a_S = 14.4487$$
$$\ln a_P = 16.3208$$

To solve for the optimum fares, it is more convenient to present the problem in matrix form: in this manner

$$\underset{E}{\begin{bmatrix} -2.2 & 0.4 & 0.77 \\ 0.3 & -2.3 & 0.99 \\ 0.34 & 0.58 & -2.0 \end{bmatrix}} \underset{P}{\begin{bmatrix} \ln(\text{low fare}) \\ \ln(\text{shoulder fare}) \\ \ln(\text{peak fare}) \end{bmatrix}} = \underset{X}{\begin{bmatrix} \ln(10{,}545) - 13.7554 \\ \ln(10{,}545) - 14.4486 \\ \ln(10{,}545) - 16.3208 \end{bmatrix}}$$

where:

E = the fare elasticity matrix,

P = the fare column vector,

X = the capacity column vector.

By setting the problem in matrix form, the optimal fares can be solved for simultaneously. In this manner the effects of the cross elasticities are included in the solution. It will be shown that a simple matrix inversion and rearrangement of the equation will yield the optimal fares.

In December 1980 (the last observed peak month) there were 10,545 Australian leisure travellers travelling from Australia to the U.S.: this figure was assumed to represent the maximum number of travellers

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2. By substituting in the values in the equation and re-arranging the equations, such that:

(Eq.1) $\ln(6{,}305) = \ln a_L - 2.2 \ln(239.23) + 0.4 \ln(338.85) + 0.77 \ln(455.72)$

$\Longrightarrow 8.7491 = \ln a_L - 5.006$

$\ln a_L = 13.7551.$

in any one month. It does not represent a 100% load factor. Generally, the level of capacity offered on any one route is determined by the demand for travel in the peak period. In the short run capacity is fixed, thus if 10,545 seats were provided each month only a small part of this capacity would be used in the off-peak. However, by adopting an appropriate set of fares, it may be possible to increase demand in the off-peak periods while discouraging some peak travellers.

As each travel season was four months long, the total number of seats offered in the peak season would be the same as in the other two seasons. Thus it was possible to equate the number of seats offered in each month to 10,545. If the seasons were of unequal lengths, it may be necessary to pro rate the number of seats offered in each month.

To solve for the optimum fares the equation is rearranged:

$$\overset{E^{-1}}{\begin{bmatrix} -0.517 & -0.1605 & -0.279 \\ -0.1193 & -0.5357 & -0.3101 \\ -0.1201 & -0.1813 & -0.636 \end{bmatrix}} \cdot \overset{\tilde{X}}{\begin{bmatrix} -4.4919 \\ -5.1853 \\ -7.0574 \end{bmatrix}} = \overset{\tilde{P}}{\begin{bmatrix} \$\ 167.94 \\ \$\ 245.22 \\ \$\ 390.75 \end{bmatrix}} \begin{matrix} \text{low} \\ \text{shoulder} \\ \text{peak} \end{matrix}$$

The optimum fares are calculated for 70%, 80%, 90% and 100% of the number of travellers in the peak season. The results are in Table 8.1.A.

TABLE 8.1.A.

Optimum fares for 70%, 80%, 90% and 100% of the number of travellers in the peak season.[3]

Season		Low $	Shoulder $	Peak $
Percentage of Peak travellers:	70%	236.23	345.42	545.91
	80%	207.89	305.79	481.65
	90%	185.76	271.03	431.34
	100%	167.94	245.22	390.75
ACTUAL FARES		239.23	338.85	455.72

3. See Appendix J. for calculation of fares at 80%.

For illustrative purposes, if the airlines did lower the number of seats offered for APEF passengers to 10,545, they would probably be aiming for an average load factor of 80% (of 10,545). The appropriate fares to charge are $207.86, $304.13 and $481.65 for the low, shoulder and peak seasons respectively.

Using the price elasticities in Table 7.4 it is possible to estimate the net effect of changing the fares from those offered in 1980 to the optimal fares calculated above. The low fare decreases by 13.10%, the shoulder fare by 9.76% and the peak fare increases by 5.69%: the change in the number of travellers for each travel season is shown in Table 8.1.B.

TABLE 8.1.B.*

The net effects of using the optimum fare at 80% of the present travellers in the peak season.

	CHANGE IN NUMBER OF TRAVELLERS		
	Low	Shoulder	Peak
The effect of decreasing the low fare by 13.10%	2,124	-290	-423
The effect of decreasing the shoulder fare by 9.76%	-288	1,658	-537
The effect of increasing the peak fare by 5.69%	323	416	-1,080
Net effect	2,159	1,784	-2,040
Present loadings	6,305	6,334	10,545
New loadings	8,464	8,118	8,505

* See Appendix K.

The new loading figures should be approximately equal to 80% of 10,545 travellers for all travel seasons. Because of rounding errors the patronage levels in the three seasons are slightly different.

The effect of the new set of fares has been to increase the patronage levels in the low and shoulder seasons while decreasing the number of travellers in the peak. The use of peak load pricing is not simply to suppress demand in the peak, but to make the peak users realise the actual cost they are imposing on the system.

B. COSTS

To complete the peak/off-peak pricing analysis, some estimate of the operating cost and capacity cost is necessary. The basic pricing principle dictates that the off-peak traveller should cover the short run marginal cost and the peak traveller should cover the long run marginal cost. The short run marginal cost is defined as the aircraft operating costs; this includes crew costs for that flight, maintenance and depreciation costs attributable to that flight. The long run marginal costs includes the operating cost and starting up costs: that is, the ownership costs, administrative and pre-operating expenses for that flight.

After calculating these costs, they are then plotted on a graph with the three demand curves representing the low, shoulder and peak demand. For convenience, the three demand curves are assumed to be independent of each other when plotted. Otherwise another three dimension would have to be added to the graph to capture the cross elasticity effects. If the three demand curves intersect the capacity curve (80% of 10,545 = 8,436 seats) at the optimum fare levels below their respective costs curves, these fares cannot be brought into operation.

Short-run marginal cost: The operating costs are taken from the Civil Aeronautics Board bulletin on *Aircraft Operating Cost.*[4] Unfortunately, operating cost data of the same detail for Qantas is unavailable.

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4. Civil Aeronautics Board, *Aircraft Operating Cost and Performance Report* (Washington D.C.; 1979), Vol. 13.

The operating cost figures used here are for Pan Am Boeing 747 used on the Pacific route for 1978. The cost figures are in U.S. dollars; a small adjustment is made to deflate these cost figures to 1970 Australian dollars.[5] The total direct operating cost (flying operations + direct maintenance + depreciation on flight equipment) per block hour[6] is U.S. $3,745.88.[7]

The flying time between Australia and the U.S. is approximately 16 hours. Thus the total operating cost of a flight from Australia to the U.S. is U.S.$59,934.08. After making the conversion to 1970 Australian dollars, the total cost is $53,704.38. The B747 has a seating capacity of 397 seats; the operating cost per seat for 100%, 90%, 80% and 70% load factors are shown in Table 8.2.A.

TABLE 8.2.A

Short run marginal costs per seat on the Australian-U.S.A. Route.

Load Factor %	Number of Occupied Seats Seats	Short run Marginal Costs $
100	397	135.28
90	357	150.44
80	318	168.89
70	278	193.19

5. The 1978 U.S. dollar cost figures are deflated by the U.S. C.P.I. (Base=1970) and adjusted for the 1978 exchange rate.

6. The time elapsed between the departure from the origin gate to the arrival at the destination gate.

7. Civil Aeronautics Board, *Aircraft Operating Costs* (Washington, D.C., 1979), Vol. 13, p. 84.

<u>Long run marginal costs</u>: The long run marginal cost includes starting up costs (ownership costs + administrative costs + pre-operating expenses). Unfortunately, neither the Civil Aeronautics Board nor the Department of Transport (Australia) report these costs. However, Douglas and Miller estimated these costs for U.S. Domestic operators in 1971.[8]

Douglas and Miller estimated ownership costs to be $1,885 1971 U.S. dollars[9] or $1,619.43 1970 Australian dollars. Thus the ownership cost for one flight on the Australian-U.S. route (16 hours flying time) is $25,910.88 in 1970 Australian dollars. The administrative costs and pre-operating expenses per passenger mile is 1.92 1971 U.S. cents or 1.65 Australian cents.[10] For a full plane the administrative costs and pre-operating expenses amount to A$58,954.50. Thus the total starting up cost for a full plane is $84,865.38.

TABLE 8.3.A

Starting Up costs and long run marginal costs on the Australia-U.S. Route.

Load Factor	Number of Seats Occupied	Starting Up Costs	Long run marginal Costs
%		$	$
100	397	213.77	349.05
90	357	237.72	388.16
80	318	266.88	435.57
70	278	305.28	498.47

C. <u>POLICY IMPLICATIONS</u> The objective of this study was firstly to estimate the cross relationship between travel seasons and secondly, to utilise the fare elasticity to derive seasonal fares that would lead to a higher level of aricraft utilisation. In economics the primary role of prices is the achievement of efficient resource

8. G. Douglas & J. Miller, *Economic Regulation of Domestic Transport*, 1974.
9. *Ibid.*, p. 23.
10. *Ibid.*, p. 8.

allocation.[11] The failure to facilitate prices in this role would necessarily lead to an inefficient use of resources. This is highlighted by the peaks and troughs in the number of Australian travellers to the U.S. prior to 1979.

Williamson's analysis of peak/off-peak pricing assumed that the two demand periods were independent of each other. This study showed that there were significant cross elasticities between travel seasons; thus in the calculation of the optimum fares given the capacity the interdependency of travel seasons was taken into account.

If the operators were to operate at 80% of the present peak loading (this is not the load factor: it is 80% of 10,545 travellers in December 1980); the optimum fares and their relevant costs are given in Table 8.4.A.

TABLE 8.4.A

Optimum fares and their cost of operations in each season at 80% of the present peak travellers.

Season	Number of Seats Occupied	Fares $	Costs $
Low	318	207.89	168.89
Shoulder	318	300.86	168.89
Peak	318	481.65	435.57

The travel seasons to consider are the low and peak travel periods - the costs are: (a) short run marginal cost for the low season;

(b) long run marginal cost for the peak season.

At 80% of the loadings both fares are above their respective costs. It would seem that the travellers in the low season are contributing

11. C.A. Cannon, "For Whom the Fare Falls: Some Selected Contemporary bills in the pricing of Transport Services", *Transport in Australia* (Australian Academy of Science, Canberra, 1978), p. 128.

to overhead costs. The effects of initiating this fare structure was shown in Table 8.2.A, which clearly shows a levelling off of travellers in each season.

If these fare changes lead to a substantial change in expenditure shares, this would affect the magnitude of the elasticities by symmetry.[12] A check of the new expenditure shares shows the expenditure share remained virtually unchanged. The expenditure shares for the 1980 fares are compared with the optimum fares below:

TABLE 8.4.B.

Comparison of 1980 expenditure fares with expenditure shares using optimum fares at 80% loadings.

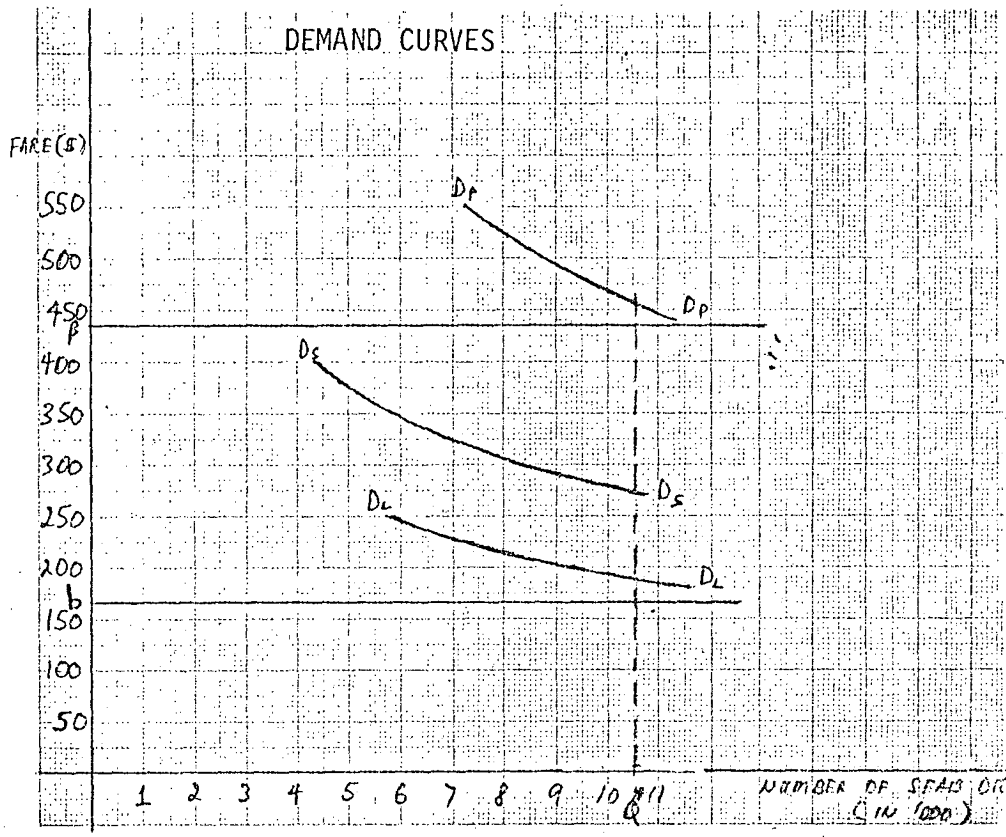
SEASON	1980 Expenditure Shares %	Expenditure shares with optimum fares %
Low	0.0475	0.047
Shoulder	0.0658	0.0676
Peak	0.11138	0.1099

The effect of the new expenditure shares on the magnitude of the elasticities would be very small; it is possible to regard this as no change. As the expenditure shares differ only slightly, the magnitude of the elasticity would remain unchanged.

The results of this analysis can be seen graphically. In Figure 8.1, the demand curves for each season are plotted; for convenience they are assumed to be independent. The demand curves D_P, D_S, D_L represent the peak, shoulder and low demand curves. Q* represents

12. J.H.E. Taplin & W.G. Waters, II: "*Intermodel Competition and Optimal Taxation of Freight Transportation: An Application of the Boiteaux Framework to Australia*. Unpublished. Univ. of Tas., 1981, p. 26.

FIGURE 8.1



Low, shoulder and peak travel demand curves with the long (β) and short (b) run marginal costs.

that maximum number of seats that would be occupied by leisure travellers. If the airlines were operating at an 80% average load factor, the operating cost is represented by b and the long run marginal cost is presented by β.

The optimal fares charged in each travel season is above their respective costs. Thus a contribution to overhead costs is being made in every season.

Thus by adopting the correct set of prices a more efficient use of resources is possible. Further, the operator now has a rational economic basis for capacity determination and investment planning.

The effect of the new set of fares has been to increase the patronage levels in the low and shoulder seasons while decreasing the number of travellers in the peak. The use of peak load pricing is not simply to suppress demand in the peak, but to make the peak users realise the actual cost they are imposing on the system.

On reflection the airline operators have set seasonal fares that have approximated the optimum fare levels. They have also followed the accepted procedure in peak load pricing, that is pricing to the relevant cost. Overall the analysis here is consistent with Williamson's theoretical exposition of peak load pricing and it has shown a practical application to the airline industry. The main benefits to be gained by the operator are a higher capacity utilisation rate and (not considering other routes) a possible reduction in the level of capacity required to service the route.

APPENDIX A.

Synthesized Matrix of Elasticities of Demand for Categories of Vacation Travel and Tourist Accommodation: Australian Travellers.

Demand for	Elasticity of demand with respect to: Overseas air fares	Price of overseas accommo-dation	Internal air fares	Price of domestic accommo-dation	Car oper-ating costs	Prices of other consumer goods & services	Income	share of expend-iture %
Vacation air trips overseas	-1.8	-1.2	+0.4	+0.4	+0.1	+0.0	+2.1	1.114
Overseas tourist accommodation	-2.2	-0.9	+0.2	+0.4	+0.1	+0.2	+2.2	0.611
Internal vacation trips by air	+1.7	+0.5	-2.1	-1.7	+0.3	+0.2	+1.1	0.255
Internal tourist accommodation	+0.7	+0.4	-0.7	-1.2	-0.4	+0.2	+1.0	0.630
Vacation car trips (internal)	+0.5	+0.3	+0.3	-1.1	-1.4	+0.7	+0.7	0.223

Source: J.H.E. Taplin, "A Coherence Approach", *J.T.E.P.*, Jan. 1980, p. 27.

APPENDIX B.

SEPARATE EQUATION RESULTS:

1) Low equation -

$$\ln TL_l = \underset{(0.75)}{6.2201\ D_1} + \underset{(0.79)}{6.5364\ D_2} + \underset{(0.79)}{6.6312\ D_3} + \underset{(0.76)}{6.4258\ D_4}$$

$$- \underset{(-4.35)}{0.8935\ \mathrm{lnlf}} - \underset{(-1.25)}{0.475\ \mathrm{lnsf}} - \underset{(-0.08)}{0.058\ \mathrm{lnpf}}$$

$$- \underset{(-1.31)}{0.7239\ \mathrm{axus}} + \underset{(5.17)}{2.66\ \mathrm{axuk}} - \underset{(-1.18)}{1.0889\ \mathrm{rdym}}$$

R^2 = 0.97, D.W. = 2.25, number of observations = 28.

2) Shoulder equation -

$$\ln TL_s = \underset{(-1.01)}{-8.0548\ D_1} - \underset{(-0.99)}{7.9073\ D_2} - \underset{(-0.97)}{7.6286\ D_3} - \underset{(-0.99)}{7.8348\ D_4}$$

$$- \underset{(-0.14)}{0.0474\ \mathrm{lnlf}} - \underset{(-1.948)}{0.9859\ \mathrm{lnsf}} + \underset{(0.465)}{0.5735\ \mathrm{lnpf}}$$

$$- \underset{(-3.53)}{4.0227\ \mathrm{axus}} - \underset{(-0.048)}{0.0535\ \mathrm{axuk}} + \underset{(0.448)}{0.2842\ \mathrm{rdym}}$$

R^2 = 0.89, D.W. - 2.51, number of observations = 28.

3) Peak equation -

$$\ln TL_p = \underset{(-0.39)}{-3.4779\ D_1} - \underset{(-0.42)}{3.7822\ D_2} - \underset{(-0.38)}{3.4688\ D_3} - \underset{(-0.37)}{3.3851\ D_4}$$

$$- \underset{(-0.45)}{0.1384\ \mathrm{lnlf}} + \underset{(1.12)}{0.7024\ \mathrm{lnsf}} - \underset{(-1.2622)}{1.2122\ \mathrm{lnpf}}$$

$$- \underset{(-5.3)}{3.1205\ \mathrm{axus}} + \underset{(2.35)}{2.1862\ \mathrm{axuk}} - \underset{(-0.16)}{0.1878\ \mathrm{rdym}}$$

R^2 = 0.86, D.W. - 1.8, number of observations = 28.

Appendix B (contd)

PEAK EQUATION CORRELATION MATRIX

	D1	D2	D3	D4	LNLF	LNSF	LNPF	AXUS	AXUK	RDYM
D1	1.000	-0.33	-0.33	-0.33	-0.0072	0.0736	0.0679	0.0451	0.011	-0.3743
D2		1.000	-0.33	-0.33	-0.0021	-0.008	0.0332	0.1048	0.0935	-0.3767
D3			1.000	-0.33	-0.0008	-0.027	-0.0596	0.0404	0.0563	-0.1158
D4				1.000	-0.0102	-0.038	-0.0415	-0.190	-0.161	0.8667
LNLF					1.000	0.9159	0.7544	0.1847	-0.6833	-0.1675
LNSF						1.000	0.6932	0.2011	-0.7131	-0.2085
LNPF							1.000	0.3639	-0.3398	-0.1326
AXUS								1.000	-0.2378	-0.2006
AXUK									1.000	0.1498
RDYM										1.000

Appendix B. (contd)

SHOULDER EQUATION CORRELATION MATRIX

	D1	D2	D3	D4	LNLF	LNSF	LNPF	AXUS	AXUK	RDYM
D1	1.000	-0.33	-0.33	-0.33	-0.0072	0.0736	0.0679	0.0852	-0.208	0.559
D2		1.000	-0.33	-0.33	-0.0021	-0.008	0.0332	-0.035	0.0186	-0.475
D3			1.000	-0.33	-0.0008	-0.027	-0.059	0.0107	0.0526	-0.293
D4				1.000	0.0102	-0.038	-0.042	-0.061	0.1367	0.2083
LNLF					1.000	0.9159	0.7544	0.3851	-0.532	-0.274
LNSF						1.000	0.6932	0.4071	-0.536	-0.205
LNPF							1.000	0.5359	-0.248	-0.144
AXUS								1.000	-0.688	-0.074
AXUK									1.000	0.1273
RDYM										1.000

Appendix B (contd)

LOW EQUATION CORRELATION MATRIX

	D1	D2	D3	D4	LNLF	LNSF	LNPF	AXUS	AXUK	RDYM
D1	1.000	-0.33	-0.33	-0.33	-0.0072	0.0736	0.0679	0.1038	-0.1198	-0.233
D2		1.000	-0.33	-0.33	-0.0021	-0.008	0.0332	0.0789	-0.0356	-0.532
D3			1.000	-0.33	-0.0008	-0.0271	-0.059	-0.123	0.0781	0.209
D4				1.000	-0.0102	-0.0386	-0.042	-0.06	0.0774	0.525
LNLF					1.000	0.9159	0.7544	0.3204	-0.5923	-0.59
LNSF						1.000	0.6932	0.3407	-0.6268	-0.59
LNPF							1.000	0.4955	-0.3517	-0.57
AXUS								1.000	-0.6051	-0.44
AXUK									1.000	0.58
RDYM										1.000

APPENDIX C.1

INTERPOLATION OF THE POPULATION FIGURES

It was assumed that this series was a multiplicative series, thus the following method was used to arrive at monthly figures:

1) $\ln \frac{X_E}{X_B} \div N = \ln i$

2) antilog $\ln i = i$

where

X_E = the observation at the end of the period

X_B = the observation at the beginning of the period

N = the number of intervening observations

i = the growth rate

X_i = the observation at period i

ln = natural logs

EXAMPLE

To determine the monthly observations for 1974 (population figures in '000s), the observation for December 1973 is 13,490.6 (X_B) and for December 1974 is 13,709.5 (X_E). By using the above method:

1) $\ln \frac{13{,}709.5}{13{,}490.6} \div 12 = 0.001341$

2) antilog 0.001341 = 1.001342

3) 13,490.6 x 1.001342 = 13,508.71 for January

13,508.71 x 1.001342 = 13,526.84 for February

13,526.84 x 1.001342 = 13,544.99 for March, and so on.

APPENDIX C.2

INTERPOLATION OF THE CONSUMER PRICE INDEX FIGURES

It was assumed here that this series was multiplicative, thus the same method was used here as for Appendix C.1.

EXAMPLE.

The raw data was based on quarterly observations, thus for the first three months in 1974:

X_B = 129.4 (December 1973 observation)

X_E = 132.5 (March 1974 observation)

n = 3

1) $\ln \frac{132.5}{129.4} \div 3 = 0.00789$

2) antilog 0.00789 = 1.007923

3) 129.4 x 1.007923 = 130.46 for January

130.46 x 1.007923 = 131.46 for February

131.46 x 1.007923 = 132.50 for March

APPENDIX C.3

INTERPOLATION OF HOUSEHOLD DISPOSABLE INCOME

The data given by the A.B.S. is quarterly, thus to arrive at monthly figures the same interpolation method as the one derived in Appendix C.1 was used.

EXAMPLE

The data is in millions of dollars. The observations for March 1974 is \$8,411 = X_E and for December 1973 is \$9,292 = X_B, n = 3

1) $\ln \frac{9292}{8411} \div 3 = 0.0332$

2) antilog 0.00332 = 1.0338

3) \$8,411 x 1.0338 = \$8,695 for January

\$8,695 x 1.0338 = \$8,989 for February

\$8,989 x 1.0338 = \$9,292 for March

These figures were then deflated by the Australian C.P.I.

(\$8,989,000.000 ÷ 130.43) x 100 = \$ 6,918,819.37

then it was divided by the Australian population:

\$6,891,891.37 ÷ 13,508,710 = \$510.18

The entire data series appears in Appendix E.

APPENDIX D.

CONSTRUCTION OF THE RELATIVE PRICES VARIABLE

The U.S. and U.K. Consumer Price Indices are given in Appendix E with the exchange rates. To construct the relative prices, the ratio of the U.S. C.P.I. to Australian C.P.I. has to be adjusted for changes in the exchange rate. (If the U.S. inflation rate is greater than the Australian inflation rate, this may cause the travel demand to decrease. However, if the exchange rate at the same time has been moving in Australia's favour, the decrease in demand due to a higher U.S. inflation rate may be offset.) The exchange rate movements are simply calculated by dividing the observation in period i by its preceding observation (i.e. $X_i \div X_{i-1}$). Table D1 shows the exchange rate movements for the U.S. dollar to the Australian dollar and Table D2 shows the exchange rate movements for the U.K. pound to the Australian dollar.

TABLE D.1

Exchange rate movements for the U.S. dollar to the Australian dollar for January 1974 to December 1980.

	1974	1975	1976	1977	1978	1979	1980
JAN.	1.00	1.0089	1.00199	1.0332	1.0047	1.0003	1.0066
FEB.	1.00	1.013791	1.0019	1.0045	0.9979	0.9917	0.9951
MAR.	1.00	1.008576	0.9916	1.0076	1.0018	0.9914	0.9874
APR.	1.00	0.9872	0.9917	1.0055	1.0024	0.9934	1.0013
MAY	1.00	0.9992	0.9978	0.9982	0.9887	0.9922	1.0353
JUNE	1.00	0.9961	0.994	1.0039	1.0091	1.0049	1.0197
JULY	1.00	0.9109	1.006	1.0128	1.0092	1.0149	1.0052
AUG.	1.00	o.9778	1.0054	0.9846	1.0048	1.0004	0.9991
SEPT.	0.9772	0.9909	1.0006	0.9995	0.9985	0.9985	1.0104
OCT.	0.901	0.9955	0.9922	1.0137	1.0134	0.9886	1.0035
NOV.	1.003	0.9998	0.9812	1.0073	0.9816	0.9819	0.9945
DEC.	1.0049	0.9928	0.8678	1.0052	0.9948	1.008	1.0003

TABLE D.2

Exchange rate movements for the U.K. pound to the Australian dollar for January 1974 to December 1980.

	1974	1975	1976	1977	1978	1979	1980
JAN.	1.0404	0.9947	0.9984	1.0111	0.9627	0.9862	0.9782
FEB.	0.9806	1.00	1.0032	1.0063	0.9916	0.9947	0.9838
MAR.	0.9711	0.9982	1.032	1.0031	1.0187	0.9754	1.0227
APR.	0.9796	1.0053	1.0419	1.0031	1.0334	0.9711	1.002
MAY	0.9888	1.0229	1.0208	1.00	1.0081	1.0037	0.9939
JUNE	1.0097	1.012	1.0219	1.0031	0.9984	0.9815	1.004
JULY	1.0016	1.0255	0.9929	1.0108	0.9807	0.9472	0.9899
AUG.	1.0176	1.0116	1.0086	0.974	0.9771	1.0099	1.00
SEPT.	0.9906	1.0033	1.0285	0.9984	0.9916	1.0138	0.9979
OCT.	0.8952	1.0098	1.0499	1.00	0.9865	1.0156	0.9979
NOV.	1.0053	1.0016	0.9842	0.978	1.0034	0.9904	1.00
DEC.	1.0035	1.008	0.8458	0.9888	0.9981	0.9749	1.0245

The U.S. and U.K. C.P.I. are then divided by the Australian C.P.I. to give a C.P.I. ratio between the countries. These ratios are presented in Tables D.3 and D.4.

TABLE D.3

The Ratio of U.S. Consumer Price Index to the Australian Consumer Price Index. 1970:100

	1974	1975	1976	1977	1978	1979	1980
JAN.	0.9154	0.8766	0.8239	0.7599	0.7437	0.753	0.7745
FEB.	0.9166	0.8715	0.8186	0.8589	0.7448	0.7552	0.7787
MAR.	0.9177	0.8665	0.8132	0.7578	0.7459	0.7574	0.7829
APR.	0.9137	0.8613	0.8089	0.8571	0.7471	0.7596	0.785
MAY	0.9098	0.8562	0.8064	0.7564	0.7484	0.7617	0.7871
JUNE	0.9058	0.8511	0.8029	0.7557	0.7497	0.7638	0.7892
JULY	0.9216	0.8546	0.8013	0.7546	0.7507	0.7665	0.7893
AUG.	0.8946	0.8581	0.7997	0.7534	0.7516	0.7692	0.7894
SEPT.	0.889	0.8616	0.8035	0.7523	0.7527	0.7719	0.7894
OCT.	0.8865	0.8507	0.7855	0.749	0.752	0.7713	0.7908
NOV.	0.8841	0.8399	0.7732	0.7458	0.7514	0.7708	0.7923
DEC.	0.8816	0.8293	0.7611	0.7427	0.7508	0.7703	0.7937

TABLE D.4

The Ratio of U.K. Consumer Price Index to the Australian Consumer Price Indec. 1970:100

	1974	1975	1976	1977	1978	1979	1980
JAN.	1.0352	1.0551	1.1521	1.1658	1.1949	1.205	1.2889
FEB.	1.0415	1.0632	1.5445	1.1763	1.1978	1.2106	1.2993
MAR.	1.0475	1.0712	1.1568	1.1868	1.2007	1.2162	1.3099
APR.	1.0534	1.0916	1.1609	1.1947	1.2033	1.2201	1.3225
MAY	1.0593	1.1122	1.1652	1.2027	1.2058	1.224	1.3353
JUNE	1.0652	1.1333	1.1694	1.2107	1.2084	1.2279	1.3482
JULY	1.0565	1.1465	1.1698	1.2092	1.2077	1.2453	1.3493
AUG.	1.0479	1.1599	1.1702	1.2077	1.2069	1.2629	1.3506
SEPT.	1.0393	1.1734	1.1706	1.2062	1.2062	1.2808	1.3517
COT.	1.0419	1.1654	1.1655	1.2015	1.2039	1.2801	1.3507
NOV.	1.0446	1.1576	1.1604	1.1968	1.2017	1.2793	1.3498
DEC.	1.0472	1.1498	1.1554	1.1921	1.1995	1.2785	1.3488

The U.S. to Australia C.P.I. rate ratio shows that for most of the series with the exception of 1979 and 1980, the Australian C.P.I. has been increasing at a faster rate. For the U.K. to Australia inflation rate ratio, the U.K. C.P.I. has been increasing at a faster rate.

The final step in the construction of the relative prices variable is that the observations in Table D.1 are multiplied by the corresponding observations in Table D.3 to obtain the relative prices between the U.S. and Australia. For the U.K. relative prices, the observations in Table D.2 are multiplied by its corresponding observations in Table D.4. Tables D.5 and D.6 present the results in this final step, and show how much more expensive/inexpensive are the cost of living in the U.S. and U.K. is relative to the Australian cost of living.

TABLE D.5

The U.S. to Australia relative prices from January 1974 to December 1980.

	1974	1975	1976	1977	1978	1980	
JAN.	0.9154	0.8844	0.8255	0.7852	0.7472	0.7532	0.7797
FEB.	0.9166	0.8836	0.8201	0.7623	0.7433	0.7489	0.7749
MAR.	0.9177	0.8739	0.808	0.7636	0.7457	0.7509	0.7731
APR.	0.9137	0.8503	0.8031	0.7613	0.7489	0.751	0.786
MAY	0.9098	0.8555	0.8047	0.7551	0.74	0.7593	0.7788
JUNE	0.9058	0.8478	0.7582	0.7586	0.756	0.7675	0.8074
JULY	0.9002	0.8383	0.8062	0.7642	0.7576	0.7779	0.7933
AUG.	0.8946	0.8428	0.804	0.7418	0.7553	0.7695	0.7886
SEPT.	0.8687	0.8538	0.7984	0.7518	0.7515	0.7707	0.7976
OCT.	0.7987	0.8391	0.7704	0.7593	0.7621	0.7625	0.7936
NOV.	0.8868	0.8398	0.7586	0.7513	0.7379	0.7848	0.7879
DEC.	0.886	0.8233	0.6604	0.7465	0.7468	0.7764	0.794

TABLE D.6

The U.K. to Australia relative prices for January 1974 to December 1980

	1974	1975	1976	1977	1978	1979	1980
JAN.	1.0071	1.0495	1.1503	1.1787	1.1503	1.1884	1.2608
FEB.	1.0212	1.0632	1.1582	1.1837	1.1877	1.2042	1.2782
MAR.	1.0034	1.0694	1.1938	1.1905	1.2232	1.1862	1.3451
APR.	1.0319	1.0973	1.2096	1.1974	1.2435	1.1849	1.3452
MAY	1.0474	1.1377	1.1894	1.2027	1.2155	1.2286	1.3273
JUNE	1.0756	1.147	1.195	1.2145	1.2065	1.2507	1.3537
JULY	1.0582	1.1758	1.1615	1.2223	1.1844	1.1795	1.3357
AUG.	1.0663	1.1734	1.1802	1.1765	1.1792	1.2755	1.3506
SEPT.	1.0295	1.1773	1.204	1.2043	1.1961	1.2985	1.349
OCT.	0.9328	1.1769	1.2236	1.2015	1.1877	1.3	1.348
NOV.	1.0501	1.1595	1.1421	1.1705	1.2058	1.2671	1.3498
DEC.	1.0509	1.159	0.9773	1.1787	1.1852	1.2462	1.3819

Generally, the U.S. and U.K. relative prices have followed the same patterns as their respective inflation rate ratios.

APPENDIX E.

RAW DATA

TABLE E.1

Australian Population "All Persons"*, January 1974 to December 1980.[1]

	1974	1975	1976	1977	1978	1979	1980
JAN.	13,509.0	13,719.9	13,861.6	14,006.1	14,178.4	14,347.1	14,533.4
FEB.	13,529.4	13,730.2	13,873.8	14,021.1	14,193.4	14,363.4	14,550.3
MAR.	13,545.9	13,740.6	13,886.1	14,036.0	14,208.3	14,379.7	14,567.2
APR.	13,563.6	13,750.9	13,895.9	14,048.7	14,221.7	14,393.8	14,983.4
MAY	13,581.3	13,761.1	13,905.7	14,061.3	14,235.2	14,407.8	14,599.6
JUNE	13,599.1	13,771.4	13,915,5	14,074.1	14,248.6	14,421.9	14,615.9
JULY	13,615.7	13,783.0	13,925.8	14,087.3	14,261.4	14,936.3	14,632.4
AUG.	13.632.4	13,794.7	13,936.2	14,100.3	12,284.2	14,450.7	14,648.9
SEPT.	13,649.1	13,806.3	13,946.5	14,113.5	14,287.0	14,465.1	14,665.4
OCT.	13,669.2	13,820.6	13,961.4	14,130.1	14,301.6	14,482.2	14,689.8
NOV.	13,689.3	13,835.0	13,976.3	14,146.8	14,316.3	14,499.3	14,706.3
DEC.	13,709.5	13,849.3	13,991.2	14,163.5	14,330.9	14,516.5	13,726.8

DEC. '73 = 13,490.6

* in '000s

1) *Source:* A.B.S., *Demography*, Catalogue Number 3101.0

TABLE E.2

Australian Consumer Prices Index,[2]
January 1974 to December 1980.

	1974	1975	1976	1977	1978	1979	1980
JAN.	130.43	152.18	173.28	197.76	215.40	232.39	256.05
FEB.	131.46	153.98	174.98	199.22	216.30	233.69	257.92
MAR.	132.6	155.8	176.7	200.7	217.2	2350.	259.8
APR.	134.31	157.58	178.19	202.29	218.69	237.08	262.21
MAY	136.14	159.38	179.69	203.89	220.19	239.18	264.64
JUNE	138.0	161.2	181.2	209.5	221.7	241.3	267.1
JULY	140.29	161.67	182.52	206.82	2232	243.12	268.76
AUG.	142.63	162.13	183.86	208.16	224.56	244.95	270.42
SEPT.	140.0	162.6	185.2	209.5	226.0	246.8	272.1
OCT.	146.78	165.55	188.83	211.15	227.69	249.24	273.99
NOV.	148.58	168.55	192.53	212.82	229.39	251.71	275.89
DEC.	150.4	171.6	196.3	214.5	231.1	254.2	277.8

DEC.'73 = 129.4

1970 = 100

2) *Source:* A.B.S. *Monthly Statistical Bulletin,* Catalogue Number 1304.0

TABLE E.3

The U.S. Consumer Price Index
January 1974 to December 1980[3]

	1973/4	1975	1976	1977	1978	1979	1980
DEC.	118.3						
JAN.	119.39	133.40	142.77	150.29	160.19	174.99	198.3
FEB.	120.49	134.20	143.23	181.19	161.69	176.49	200.83
MAR.	121.6	135.0	143.7	152.1	162.0	178.0	203.4
APR.	122.72	135.73	144.3	153.16	163.39	180.08	205.84
MAY	123.86	136.46	144.9	154.23	164.79	182.18	208.30
JUNE	125.0	137.2	145.5	155.3	166.2	184.3	210.8
JULY	126.29	138.16	146.26	156.06	167.49	186.54	212.12
AUG.	128.9	140.1	147.8	157.6	170.1	190.5	214.8
OCT.	130.12	140.83	148.33	158.16	171.23	192.25	216.68
NOV.	131.36	141.36	148.86	158.73	172.36	194.02	218.58
DEC.	132.6	142.3	149.4	159.3	173.5	195.8	220.5

1970 = 100

3) *Source:* *Monthly Statistical Bulletin,* Catalogue Number 1304.0

TABLE E.4

The U.K. Consumer Price Index, January 1974 to December 1980[4]

	1974	1975	1976	1977	1978	1979	1980
U.K.	1970 = 100						
DEC.	133.2						
JAN.	135.04	160.57	199.64	230.54	257.39	280.04	330.02
FEB.	136.91	163.71	202.01	234.34	259.09	282.90	335.12
MAR.	138.8	166.9	204.4	238.2	260.8	289.8	340.3
APR.	141.48	172.01	206.87	241.68	263.15	289.26	346.78
MAY	144.21	177.27	209.37	245.22	265.51	292.76	353.38
JUNE	147.0	182.7	211.9	248.8	267.9	296.3	360.1
JULY	148.22	185.36	213.52	250.09	269.46	302.76	362.65
AUG.	149.46	188.06	215.15	251.39	271.02	309.36	365.22
SEPT.	150.7	190.8	216.8	252.7	272.6	316.1	367.8
OCT.	152.93	192.94	220.08	253.7	274.12	319.04	370.09
NOV.	155.20	195.11	223.42	254.7	275.66	322.01	372.39
DEC.	197.5	197.3	226.8	255.7	277.2	325.0	374.7

4) *Source:* A.B.S., *Monthly Statistical Bulletin* Catalogue Number 1304.0

TABLE E.5

The U.S. Dollar to Australian Dollar Exchange Rate, January 1974 to December 1980.[5]

	1974	1975	1976	1977	1978	1979	1980
JAN.	1.49	1.3342	1.2613	1.0889	1.1414	1.1437	1.1121
FEB.	1.49	1.3526	1.2637	1.0938	1.1391	1.1342	1.1067
MAR.	1.49	1.3642	1.2531	1.1021	1.1411	1.1244	1.0928
APR.	1.49	1.3467	1.2427	1.1082	1.1438	1.1117	1.0942
MAY	1.49	1.3456	1.24	1.1062	1.1309	1.1083	1.1328
JUNE	1.49	1.3403	1.2326	1.1105	1.1412	1.1137	1.1551
JULY	1.49	1.3147	1.24	1.1247	1.1517	1.1304	1.1611
AUG.	1.49	1.2855	1.2467	1.1074	1.1572	1.1308	1.16
SEPT.	1.456	1.2738	1.2475	1.1068	1.1555	1.1291	1.1721
OCT.	1.3119	1.2681	1.2398	1.122	1.171	1.1162	1.1762
NOV.	1.3159	1.2679	1.2145	1.1302	1.1494	1.096	1.1697
DEC.	1.3224	1.2588	1.0539	1.1361	1.1434	1.1048	1.1701

DEC. 1973 = 1.49

5) *Source:* A.B.S. *Banking Australian Quarterly,* Catalogue Number 5605.0

TABLE E.6

The U.K. Pound to Australian Dollar Exchange Rate, January 1974 to December 1980.[6]

	1974	1975	1976	1977	1978	1979	1980
JAN.	0.67	0.566	0.623	0.638	0.593	0.571	0.493
FEB.	0.657	0.566	0.625	0.642	0.588	0.568	0.485
MAR.	0.638	0.565	0.645	0.644	0.599	0.554	0.496
APR.	0.625	0.568	0.672	0.646	0.619	0.538	0.497
MAY	0.618	0.581	0.686	0.646	0.624	0.54	0.494
JUNE	0.624	0.588	0.701	0.648	0.623	0.53	0.496
JULY	0.625	0.603	0.696	0.655	0.611	0.502	0.491
AUG.	0.636	0.61	0.702	0.638	0.597	0.507	0.491
SEPT.	0.63	0.612	0.722	0.637	0.592	0.514	0.49
OCT.	0.564	0.618	0.758	0.637	0.584	0.522	0.489
NOV.	0.567	0.619	0.746	0.623	0.586	0.517	0.489
DEC.	0.569	0.624	0.631	0.616	0.579	0.504	0.501

DEC. 1973 : 0.644

6) *Source:* A.B.S. *Banking Australia Quarterly*, Catalogue Number 5605.0

TABLE E.7

Australian Residents departing for the U.S.A. for the short term, by purpose from January 1974 to December 1980.[7]

	1974				1975			
	Business and Other	V.F.R.	Leisure	Total	Business and Other	V.F.R.	Leisure	Total
JAN.	1231	156	2,118	3,505	1,466	155	2,944	4,619
FEB.	947	215	1,239	2,401	1,071	214	1331	2,616
MAR.	1523	318	1,490	3,331	1,427	315	2,354	4,096
APR.	1580	531	2,016	4,128	1,438	526	2,347	4,311
MAY	1734	757	2,741	5,232	1,649	749	4,325	6,723
JUNE	1724	890	2,226	4,840	1,523	879	3,042	5,444
JULY	1352	544	2,611	4,507	1,563	544	3,629	5,736
AUG.	1676	805	3,833	6,314	1,736	826	5,833	8,395
SEPT.	1654	385	2,454	4,493	1,706	400	3,099	5,205
OCT.	1451	221	1,589	3,261	2,020	233	3,304	5,557
NOV.	903	330	1,711	2,944	1,274	352	2,253	3,879
DEC.	1150	1,702	4,417	7,269	1,010	1,837	7,011	9,858
	1976				1977			
JAN	1448	310	3,872	5,630	1,503	348	4,514	6,369
FEB.	1337	184	2,306	3,827	1,308	207	1,973	,3488
MAR.	1555	626	2,680	4,861	1,658	520	3,200	5,378
APR.	1778	639	3,472	5,889	2,300	599	3,998	6,897
MAY	2584	1093	6,896	10,573	2,104	780	6,221	9,105
JUNE	2620	1024	5,107	8,751	2,234	1031	4,806	8,071
JULY	2144	1058	5,610	8,812	2,411	862	5,846	9,119
AUG.	2135	966	5,067	8,168	2,332	1074	7,679	11,081
SEPT.	1983	620	4,228	6,831	2,248	627	5,242	9,117
OCT.	2122	367	3,374	5,863	2,370	387	3,415	6,172
NOV.	1294	426	2,457	4,177	1,279	417	2,461	4,157
DEC.	1552	2524	7,862	11,948	1,483	2398	7,871	11,752

TABLE E.7 (cont.)

	1978				1979			
	Business and Other	V.F.R.	Leisure	Total	Business and Other	V.F.R.	Leisure	Total
JAN.	1,881	310	3,842	6,003	1,997	308	4,659	6,964
FEB.	1,531	185	2,444	4,160	2,390	831	4,438	7,659
MAR.	2,064	394	3,110	5,568	3,266	1826	7,794	12,886
APR.	2,685	901	4,894	8,280	2,943	1501	8,138	12,582
MAY	2,810	1052	8,368	12,230	3,481	1392	12,0002	16,875
JUNE	2,951	959	6,484	10,390	3,097	1036	7,120	11,293
JULY	2,874	1074	7,126	11,074	2,964	1170	8,369	12,503
AUG.	2,451	1255	9,612	13,318	3,172	956	10,245	14,373
SEPT.	3,421	567	6,478	10,466	3,706	1133	7,623	12,462
OCT.	3,686	551	3,594	7,829	3,308	1462	9,842	14,612
NOV.	1,784	477	2,639	4,896	2,308	1117	9,490	8,875
DEC.	1,773	2371	9,699	13,849	1,937	2098	9,811	13,846

	1980			
JAN.	2,335	534	5,827	8,696
FEB.	2,807	936	6,847	10,590
MAR.	3,651	1445	9,929	15,025
APR.	3,360	1205	6,510	11,345
MAY	3,441	1526	10,631	15,598
JUNE	3,931	1079	5,374	10,385
JULY	3,976	1287	6,510	11,773
AUG.	3,810	902	7,949	12,661
SEPT.	4,550	724	5,610	10,884
OCT.	3,450	1222	6,987	11,659
NOV.	3,728	1257	5,048	10,033
DEC.	2,876	2148	8,397	13,421.

7) *Source:* A.B.S. Canberra.

TABLE E.9

Real Disposable Monthly Income per capita[9,10]

	1974	1975	1976	1977	1978	1979	1980
JAN.	510.17	523.83	534.34	512.31	545.19	585.83	573.66
FEB.	488.96	474.22	506.25	491.58	516.65	582.97	535.96
MAR.	468.62	474.77	479.71	471.63	489.60	540.97	500.75
APR.	472.62	479.40	490.20	478.22	483.91	301.56	491.68
MAY	476.71	490.42	501.01	484.95	477.66	500.56	488.77
JUNE	480.75	501.69	512.06	491.74	471.80	481.49	474.04
JULY	476.76	498.72	510.20	493.54	496.05	503.27	499.05
AUG.	472.81	495.84	508.30	495.32	521.05	526.02	525.37
SEPT.	468.90	492.95	506.39	497.11	548.26	549.81	553.08
OCT.	495.63	521.27	515.42	521.93	567.99	570.41	579.82
NOV.	523.92	545.01	524.60	547.97	588.44	591.80	607.90
DEC.	553.79	564.07	533.96	575.28	609.59	613.95	637.30

9) Original data was taken from the A.B.S. Bulletin *Quarterly Estimates of Income and Expenditure.*

10) To see how these figures were derived, see Appendix C.3.

TABLE E.10

Real Advanced Purchase Fares on the Australia-U.S.A. Pacifiic air route (1970 Australian dollars)[11]

	1974	1975	1976	1977	1978	1979	1980
JAN.	474.58	441.84	470.05	440.94	414.97	409.66	324.16
FEB.	470.87	436.68	465.48	477.86	439.34	192.56	215.57
MAR.	467.17	431.58	460.95	474.34	438.31	191.49	230.18
APR.	476.58	464.46	457.10	470.61	435.30	291.04	340.95
MAY	470.16	459.22	485.28	466.92	432.35	374.61	433.04
JUNE	463.84	454.03	481.24	463.26	429.41	385.41	429.05
JULY	456.27	452.71	477.56	460.30	427.68	297.80	343.06
AUG.	448.78	451.43	474.27	457.34	423.94	379.67	437.36
SEPT.	441.45	450.12	470.84	454.42	421.24	320.10	338.85
OCT.	436.09	442.10	461.79	450.86	418.11	211.84	240.88
NOV.	452.55	469.00	452.92	447.33	415.01	209.77	239.23
DEC.	$$&.07	474.65	444.22	443.82	411.94	398.90	455.72

11) *Source:* The Department of Transport, Canberra.

TABLE E.11

Published real advanced purchase fares, low season, January 1974 to December 1980

	1974	1975	1976	1977	1978	1979	1980
JAN.	470.87	436.68	465.48	477.86	439.34	192.56	215.57
FEB.	470.87	436.68	465.48	477.86	439.34	192.56	215.57
MAR.	467.17	431.58	460.95	474.34	438.31	191.49	230.18
APR.	467.17	431.58	460.95	474.34	438.31	191.49	230.18
MAY	470.87	436.68	465.48	477.86	439.34	192.56	215.57
JUNE	467.17	431.58	460.95	474.34	438.31	191.49	230.18
JULY	436.09	442.10	461.79	450.86	418.11	211.84	240.88
AUG.	436.09	442.10	461.79	450.86	418.11	211.84	240.88
SEPT.	452.55	469.00	452.92	447.33	415.01	209.77	239.23
OCT.	436.09	442.10	461.79	450.86	418.11	211.84	240.88
NOV.	452.55	469.00	452.92	447.33	415.01	209.77	239.23
DEC.	452.55	469.00	452.92	447.33	415.01	209.77	239.23

N.B. Seasonal fares came into operation in January 1979.

TABLE E.12

Published real advanced purchase fares, shoulder season, January 1974 to December 1980.

	1974	1975	1976	1977	1978	1979	1980
JAN.	474.58	441.85	470.05	440.94	414.97	409.66	324.16
FEB.	474.58	441.85	470.05	440.94	414.97	409.66	324.16
MAR.	476.58	464.46	457.10	470.61	435.32	291.04	340.95
APR.	476.58	464.46	457.10	470.61	435.32	291.04	340.95
MAY	474.58	441.85	470.05	440.94	414.97	409.66	324.16
JUNE	476.58	441.85	470.05	440.94	414.97	409.66	324.16
JULY	456.27	452.71	477.76	460.30	427.68	297.80	343.06
AUG.	456.27	452.71	477.76	460.30	427.68	297.80	343.06
SEPT.	441.45	450.12	470.84	454.42	421.24	320.10	338.85
OCT.	456.27	452.71	477.76	460.30	427.68	297.80	343.06
NOV.	441.45	450.12	470.84	454.42	421.24	320.10	338.85
DEC.	441.45	450.12	470.84	454.42	421.24	320.10	338.85

TABLE E.13

Published real advanced purchase fares, peak season, January 1974 to December 1980.

	1974	1975	1976	1977	1978	1979	1980
JAN.	470.16	459.22	485.28	466.92	432.35	374.61	433.04
FEB.	470.16	459.22	485.28	466.92	432.35	374.61	433.04
MAR.	463.84	454.03	481.24	463.26	429.41	385.41	429.05
APR.	463.84	454.03	481.24	463.26	429.41	385.41	429.05
MAY	470.16	459.22	485.28	466.92	432.35	374.61	433.04
JUNE	463.84	454.03	481.24	463.26	429.41	385.41	429.05
JULY	448.78	451.43	474.27	457.34	423.94	379.67	436.36
AUG.	448.78	431.43	474.27	457.34	423.94	379.67	436.36
SEPT.	447.07	464.65	444.22	443.82	411.94	398.90	455.72
OCT.	448.78	451.43	474.27	457.34	423.94	379.67	436.36
NOV.	447.07	474.65	444.22	443.82	411.93	398.90	455.72
DEC.	447.07	474.64	444.22	443.82	411.94	398.90	455.72

TABLE. E.14

Total per capita leisure passngers monthly data January 1974 to December 1980.

	1974	1975	1966	1977	1978	1979	1980
JAN.	0.000168	0.00023	0.000302	0.000347	0.000293	0.000346	0.00346
FEB.	0.000107	0.000113	0.000179	0.000155	0.000185	0.000367	0.000535
MAR.	0.000133	0.000194	0.000238	0.000265	0.000247	0.000669	0.000781
APR.	0.000188	0.000209	0.000295	0.000327	0.000393	0.00067	0.000529
MAY	0.000258	0.000369	0.000575	0.000498	0.000622	0.00093	0.000833
JUNE	0.000299	0.000285	0.000441	0.000415	0.000522	0.000566	0.000442
JULY	0.000232	0.000303	0.000479	0.000476	0.000575	0.000681	0.000533
AUG.	0.00034	0.000483	0.000433	0.00062	0.000761	0.000755	0.000604
SEPT.	0.000208	0.000253	0.000348	0.000487	0.000493	0.000605	0.000432
OCT.	0.000132	0.000256	0.000268	0.000269	0.00029	0.000781	0.000559
NOV.	0.000149	0.000188	0.000206	0.000203	0.000217	0.00046	0.000429
DEC.	0.000238	0.000639	0.000742	0.000725	0.000842	0.000542	0.000716

APPENDIX F.1

CALCULATION OF THE PRICE ELASTICITIES

By using the interaction terms, a full set of these terms with the original variables cannot be speficied for the model: this would cause singularity and the solution would be indeterminant. Thus, a base period is required from which other interaction terms would measure marginal changes. The base for equation 1 in Chapter 6 is the low period; thus every other interaction term must be added with the estimated coefficients of that period (i.e. LNLF, LNSF, LNPF, LNAXUS, LNAXUK, LNRDYM). To calculate the elasticities for the shoulder period:

Fare elasticities:

LNLF + DSLNLF = -0.8938 + 0.8456 = -0.0482

LNSF + DSLNSF = -0.4746 + 0.5112 = 0.9858

LNPF + DSLNPF = -0.0573 + 0.6345 = 0.5772

Relative Price elasticities:

LNAXUS + DASXUS = -0.7236 + -3.3049 = -4.0265

LNAXUK + DASXUK = 2.6597 + -2.7176 = -0.0579

Income elasticity:

LNRDYM + DSRDYM = -1.0882 + 1.3787 = 0.2845

The same process is carried out for the peak season elasticities.

APPENDIX G.1 CORRELATION MATRIX FOR EQUATION 2.

CORRELATION MATRIX

	LNT	DJ	DF	DM	DA	DMY
LNT	1.00000	-0.139025	-0.341983	-0.111463	-.368217E-01	0.228473
DJ	-0.139025	1.00000	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DF	-0.341983	-.909091E-01	1.00000	-.909091E-01	-.909091E-01	-.909091E-01
DM	-0.111463	-.909091E-01	-.909091E-01	1.00000	-.909091E-01	-.909091E-01
DA	-.368217E-01	-.909091E-01	-.909091E-01	-.909091E-01	1.00000	-.909091E-01
DMY	0.228473	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	1.00000
DJN	.508956E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DJL	0.112671	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DAG	0.237889	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DST	.261550E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DOC	-.803440E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DNV	-0.227406	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DDC	0.280960	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
LNLF	-0.544800	-.378295E-02	-.378295E-02	-.111760E-02	-.111760E-02	-.378295E-02
LNSF	-0.556390	.384338E-01	.384338E-01	-.414736E-02	-.414736E-02	.384338E-01
LNPF	-0.481491	.354418E-01	.354418E-01	.173558E-01	.173558E-01	.354418E-01
DSLNLF	-.388222E-01	0.424905	-0.212681	-0.212681	0.425227	-0.212681
DSLNSF	-.303369E-01	0.428275	-0.213096	-0.213096	0.425968	-0.213096
DSLNPF	-.251414E-01	0.427207	-0.213180	-0.213180	0.426775	-0.213180
DPLNLF	0.454222	-0.212681	-0.212681	-0.212681	-0.212681	0.424905
DPLNSF	0.462397	-0.213096	-0.213096	-0.213096	-0.213096	0.428275
DPLNPF	0.465137	-0.213180	-0.213180	-0.213180	-0.213180	0.427207
LNAXUS	-0.567961	.738746E-01	.399195E-01	.274123E-01	.145179E-01	.526439E-02
D2AXUS	-.910539E-01	-0.376116	0.200931	0.200931	-0.412294	0.200931
D3AXUS	-0.553739	0.199107	0.199107	0.199107	0.199107	-0.383970
LNAXUK	0.617938	-0.102889	-.868253E-01	-.382821E-01	.263502E-02	.303926E-01
D2AXUK	0.121046	0.290312	-0.188876	-0.188876	0.386436	-0.188876
D3AXUK	0.508308	-0.185776	-0.185776	-0.185776	-0.185776	0.376451
LNRDYM	0.232386	0.259383	-.591895E-01	-0.224291	-0.252964	-0.234188
D2RDY	-.216262E-01	0.433663	-0.213178	-0.213178	0.420152	-0.213178
D3RDY	0.470334	-0.213172	-0.213172	-0.213172	-0.213172	0.420828
	1	2	3	4	5	6

	DJN	DJL	DAG	DST	DOC	DNV
LNT	.508956E-01	0.112671	0.237889	.261550E-01	-.803440E-01	-0.227406
DJ	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DF	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DM	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DA	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DMY	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DJN	1.00000	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DJL	-.909091E-01	1.00000	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DAG	-.909091E-01	-.909091E-01	1.00000	-.909091E-01	-.909091E-01	-.909091E-01
DST	-.909091E-01	-.909091E-01	-.909091E-01	1.00000	-.909091E-01	-.909091E-01
DOC	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	1.00000	-.909091E-01
DNV	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	1.00000
DDC	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01

	DJN	DJL	DAG	DST	DOC	DNV
LNLF	-.111760E-02	-.408923E-03	-.408923E-03	.530947E-02	-.408923E-03	.530947E-02
LNSF	-.414736E-02	-.141338E-01	-.141338E-01	-.201526E-01	-.141338E-01	-.201526E-01
LNPF	.173558E-01	-.311046E-01	-.311046E-01	-.216930E-01	-.311046E-01	-.216930E-01
DSLNLF	-0.212681	0.425313	-0.212681	0.426004	-0.212681	-0.212681
DSLNSF	-0.213096	0.425427	-0.213096	0.425101	-0.213096	-0.213096
DSLNPF	-0.213180	0.425618	-0.213180	0.425843	-0.213180	-0.213180
DPLNLF	0.425227	-0.212681	0.425313	-0.212681	-0.212681	-0.212681
DPLNSF	0.425968	-0.213096	0.425427	-0.213096	-0.213096	-0.213096
DPLNPF	0.426775	-0.213180	0.425618	-0.213180	-0.213180	-0.213180
LNAXUS	.387664E-01	.370183E-01	.489223E-02	.130375E-02	-.737012E-01	-.424451E-01
D2AXUS	0.200931	-0.398618	0.200931	-0.420422	0.200931	0.200931
D3AXUS	-0.364701	0.199107	-0.384184	0.199107	0.199107	0.199107
LNAXUK	.733150E-01	.169798E-01	.539691E-01	.556836E-01	.272394E-01	.268668E-01
D2AXUK	-0.188876	0.399503	-0.188876	0.434759	-0.188876	-0.188876
D3AXUK	0.413052	-0.185776	0.396555	-0.185776	-0.185776	-0.185776
LNRDYM	-0.235525	-0.162649	-.897599E-01	.855780E-01	0.147899	0.306461
D2RDY	-0.213178	0.422533	-0.213178	0.429080	-0.213178	-0.213178
D3RDY	0.420793	-0.213172	0.424638	-0.213172	-0.213172	-0.213172
	7	8	9	10	11	12

	DDC	LNLF	LNSF	LNPF	DSLNLF	DSLNSF
LNT	0.280960	-0.544800	-0.556390	-0.481491	-.388222E-01	-.303369E-01
DJ	-.909091E-01	-.378295E-02	.384338E-01	.354418E-01	0.424905	0.428275
DF	-.909091E-01	-.378295E-02	.384338E-01	.354418E-01	-0.212681	-0.213096
DM	-.909091E-01	-.111760E-02	-.414736E-02	.173558E-01	-0.212681	-0.213096
DA	-.909091E-01	-.111760E-02	-.414736E-02	.173558E-01	0.425227	0.425968
DMY	-.909091E-01	-.378295E-02	.384338E-01	.354418E-01	-0.212681	-0.213096
DJN	-.909091E-01	-.111760E-02	-.414736E-02	.173558E-01	-0.212681	-0.213096
DJL	-.909091E-01	-.408923E-03	-.141338E-01	-.311046E-01	0.425313	0.425427
DAG	-.909091E-01	-.408923E-03	-.141338E-01	-.311046E-01	-0.212681	-0.213096
DST	-.909091E-01	.530947E-02	-.201526E-01	-.216930E-01	0.426004	0.425101
DOC	-.909091E-01	-.408923E-03	-.141338E-01	-.311046E-01	-0.212681	-0.213096
DNV	-.909091E-01	.530947E-02	-.201526E-01	-.216930E-01	-0.212681	-0.213096
DDC	1.00000	.530947E-02	-.201526E-01	-.216930E-01	-0.212681	-0.213096
LNLF	.530947E-02	1.00000	0.915900	0.754424	.402831E-01	.165381E-01
LNSF	-.201526E-01	0.915900	1.00000	0.693192	.368953E-01	.180566E-01
LNPF	-.216930E-01	0.754424	0.693192	1.00000	.303905E-01	.125167E-01
DSLNLF	-0.212681	.402831E-01	.368953E-01	.303905E-01	1.00000	0.999074
DSLNSF	-0.213096	.165381E-01	.180566E-01	.125167E-01	0.999074	1.00000
DSLNPF	-0.213180	.600573E-02	.551829E-02	.796068E-02	0.998194	0.999715
DPLNLF	0.426004	.402831E-01	.368953E-01	.303905E-01	-0.497566	-0.498537
DPLNSF	0.425101	.165381E-01	.180566E-01	.125167E-01	-0.498537	-0.499511
DPLNPF	0.425843	.600573E-02	.551829E-02	.796068E-02	-0.498734	-0.499708
LNAXUS	-0.126923	0.290942	0.310299	0.458833	.888835E-01	.812881E-01
D2AXUS	0.200931	.743300E-01	.785983E-01	0.103457	-0.931171	-0.937733
D3AXUS	-0.459999	.382713E-01	.416527E-01	.751270E-01	0.465809	0.466719
LNAXUK	-.590853E-01	-0.600991	-0.624869	-0.315080	-.349987E-01	-.246941E-01
D2AXUK	-0.188876	-0.142175	-0.143370	-.663397E-01	0.866567	0.877708
D3AXUK	0.300150	-0.193559	-0.201983	-.962450E-01	-0.434621	-0.435470
LNRDYM	0.459245	-0.335429	-0.328848	-0.274949	-.518130E-01	-.449234E-01
D2RDY	-0.213178	-.228930E-02	-.171386E-02	-.120537E-02	0.997182	0.999314
D3RDY	0.439120	-.157592E-02	-.196158E-02	-.124772E-02	-0.498715	-0.499689

DDC LNLF LNSF LNPF DSLNLF DSLNSF
13 14 15 16 17 18

	DSLNPF	DPLNLF	DPLNSF	DPLNPF	LNAXUS	D2AXUS
LNT	-.251414E-01	0.454222	0.462397	0.465137	-0.567961	-.910539E-01
DJ	0.427207	-0.212681	-0.213096	-0.213180	.738746E-01	-0.376116
DF	-0.213180	-0.212681	-0.213096	-0.213180	.399195E-01	0.200931
DM	-0.213180	-0.212681	-0.213096	-0.213180	.274123E-01	0.200931
DA	0.426775	-0.212681	-0.213096	-0.213180	.146179E-01	-0.412294
DMY	-0.213180	0.424905	0.428275	0.427207	.526439E-02	0.200931
DJN	-0.213180	0.425227	0.425968	0.426775	.387664E-01	0.200931
DJL	0.425618	-0.212681	-0.213096	-0.213180	.370183E-01	-0.398618
DAG	-0.213180	0.425313	0.425427	0.425618	.489223E-02	0.200931
DST	0.425843	-0.212681	-0.213096	-0.213180	.130375E-02	-0.420422
DOC	-0.213180	-0.212681	-0.213096	-0.213180	-.737012E-01	0.200931
DNV	-0.213180	-0.212681	-0.213096	-0.213180	-.424451E-01	0.200931
DDC	-0.213180	0.426004	0.425101	0.425843	-0.126923	0.200931
LNLF	.600573E-02	.402831E-01	.165381E-01	.600573E-02	0.290942	.743300E-01
LNSF	.551829E-02	.368953E-01	.180566E-01	.551829E-02	0.310299	.785883E-01
LNPF	.796068E-02	.303905E-01	.125167E-01	.796068E-02	0.458833	0.103457
DSLNLF	0.998194	-0.497566	-0.498537	-0.498734	.888835E-01	-0.931171
DSLNSF	0.999715	-0.498537	-0.499511	-0.499708	.812881E-01	-0.937733
DSLNPF	1.00000	-0.498734	-0.499708	-0.499905	.783915E-01	-0.939890
DPLNLF	-0.498734	1.00000	0.999074	0.998194	-.375789E-01	0.470077
DPLNSF	-0.499708	0.999074	1.00000	0.999715	-.417864E-01	0.470995
DPLNPF	-0.499905	0.998194	0.999715	1.00000	-.426079E-01	0.471181
LNAXUS	.783915E-01	-.375789E-01	-.417864E-01	-.426079E-01	1.00000	0.113024
D2AXUS	-0.939890	0.470077	0.470995	0.471181	0.113024	1.000000
D3AXUS	0.466903	-0.926993	-0.931181	-0.932011	0.264979	-0.440075
LNAXUK	-.179140E-01	.302321E-01	.449450E-01	.551034E-01	-0.492943	-0.102063
D2AXUK	0.884239	-0.441874	-0.442737	-0.442912	-0.109157	-0.941783
D3AXUK	-0.435642	0.845851	0.859999	0.868985	-0.112342	0.410610
LNRDYM	-.425109E-01	-.658401E-01	-.627630E-01	-.598877E-01	-0.238084	.254165E-01
D2RDY	0.999772	-0.498729	-0.499703	-0.499900	.737555E-01	-0.942712
D3RDY	-0.499886	0.997240	0.999272	0.999742	-.477630E-01	0.471163

19 20 21 22 23 24

	D3AXUS	LNAXUK	D2AXUK	D3AXUK	LNRDYM	D2RDY
LNT	-0.553739	0.617938	0.121046	0.508308	0.232386	-.216262E-01
DJ	0.199107	-0.102889	0.290312	-0.185776	0.259383	0.433663
DF	0.199107	-.868253E-01	-0.188876	-0.185776	-.591895E-01	-0.213178
DM	0.199107	-.382821E-01	-0.188876	-0.185776	-0.224291	-0.213178
DA	0.199107	.263502E-02	0.386436	-0.185776	-0.252964	0.420152
DMY	-0.383970	.303926E-01	-0.188876	0.376451	-0.234188	-0.213178
DJN	-0.364701	.733150E-01	-0.188876	0.413052	-0.235525	-0.213178
DJL	0.199107	.169798E-01	0.399503	-0.185776	-0.162649	0.422533
DAG	-0.394184	.539691E-01	-0.188876	0.396555	-.897599E-01	-0.213178
DST	0.199107	.556836E-01	0.434759	-0.185776	.855780E-01	0.429080
DOC	0.199107	.272394E-01	-0.188876	-0.185776	0.147899	-0.213178
DNV	0.199107	.268668E-01	-0.188876	-0.185776	0.306461	-0.213178

	D3AXUS	LNAXUK	D2AXUK	D3AXUK	LNRDYM	D2RDY
DDC	-0.459999	-.590853E-01	-0.188876	0.300150	0.459245	-0.213178
LNLF	.382713E-01	-0.600991	-0.142175	-0.193559	-0.335429	-.228930E-02
LNSF	.416527E-01	-0.624869	-0.143370	-0.201983	-0.328848	-.171386E-02
LNPF	.751270E-01	-0.315080	-.663397E-01	-.962450E-01	-0.274949	-.120537E-02
DSLNLF	0.465809	-.349987E-01	0.866567	-0.434621	-.518130E-01	0.997182
DSLNSF	0.466719	-.246941E-01	0.877708	-0.435470	-.449234E-01	0.999314
DSLNPF	0.466903	-.179140E-01	0.884239	-0.435642	-.425109E-01	0.999772
DPLNLF	-0.926993	.302321E-01	-0.441874	0.845851	-.658401E-01	-0.498729
DPLNSF	-0.931181	.449450E-01	-0.442737	0.859999	-.627630E-01	-0.499703
DPLNPF	-0.932011	.551034E-01	-0.442912	0.866985	-.598877E-01	-0.499900
LNAXUS	0.264979	-0.492943	-0.109157	-0.112342	-0.238084	.737555E-01
D2AXUS	-0.440075	-0.102063	-0.941733	0.410610	.254165E-01	-0.942712
D3AXUS	1.00000	-0.102879	0.413672	-0.855459	.104572E-01	0.466898
LNAXUK	-0.102879	1.000000	0.221877	0.332664	0.288740	-.152462E-01
D2AXUK	0.413672	0.221877	1.00000	-0.385975	-.463055E-02	0.886661
D3AXUK	-0.855459	0.332664	-0.385975	1.00200	-.580368E-02	-0.435638
LNRDYM	.104572E-01	0.288740	-.463055E-02	-.580368E-02	1.00000	-.334979E-01
D2RDY	0.466898	-.152462E-01	0.886661	-0.435638	-.334979E-01	1.00000
D3RDY	-0.934942	.592012E-01	-0.442895	0.872448	-.486888E-01	-0.499881
	25	26	27	28	29	30

	D3RDY
LNT	0.470334
DJ	-0.213172
DF	-0.213172
DM	-0.213172
DA	-0.213172
DMY	0.420828
DJN	0.420793
DJL	-0.213172
DAG	0.424638
DST	-0.213172
DOC	-0.213172
DNV	-0.213172
DDC	0.439120
LNLF	-.157592E-02
LNSF	-.196158E-02
LNPF	-.124772E-02
DSLNLF	-0.498715
DSLNSF	-0.499689
DSLNPF	-0.499886
DPLNLF	0.997240
DPLNSF	0.999272
DPLNPF	0.999742
LNAXUS	-.477630E-01
D2AXUS	0.471163
D3AXUS	-0.934942
LNAXUK	.592012E-01
D2AXUK	-0.442895
D3AXUK	0.872448
LNRDYM	-.486888E-01
D2RDY	-0.499881

CORRELATION MATRIX

	LNT	DLLNLF	DLLNSF	DLLNPF	DSLNLF	DSLNSF
LNT	1.00000	-0.481239	-0.462199	-0.451495	-.338222E-01	-.323369E-01
DLLNLF	-0.481239	1.00000	0.999074	0.998194	-0.497566	-0.498537
DLLNSF	-0.462199	0.999074	1.00000	0.999715	-0.498537	-0.499511
DLLNPF	-0.451495	0.998194	0.999715	1.00000	-0.498734	-0.499728
DSLNLF	-.338222E-01	-0.497566	-0.498537	-0.498734	1.00000	0.999074
DSLNSF	-.323369E-01	-0.498537	-0.499511	-0.499708	0.999074	1.00000
DSLNPF	-.251414E-01	-0.498734	-0.499708	-0.499905	0.998194	0.999715
DPLNLF	0.454222	-0.497566	-0.498537	-0.498734	-0.497566	-0.498537
DPLNSF	0.462397	-0.498537	-0.499511	-0.499708	-0.498537	-0.499511
DPLNPF	0.465137	-0.498734	-0.499708	-0.499905	-0.498734	-0.499708
D1AXUS	0.318995	-0.935968	-0.941618	-0.943234	0.471622	0.472543
D2AXUS	-.910539E-01	0.470277	0.470995	0.471181	-0.931171	-0.937733
D3AXUS	-0.553739	0.465809	0.466719	0.466903	0.465809	0.466719
D1AXUK	-.966784E-01	0.807012	0.822686	0.829240	-0.414971	-0.415781
D2AXUK	0.121046	-0.441874	-0.442737	-0.442912	0.866567	0.877706
D3AXUK	0.508308	-0.434621	-0.435470	-0.435642	-0.434621	-0.435470
D1RDY	-0.441353	0.996856	0.999134	0.999664	-0.498729	-0.499702
D2RDY	-.216262E-01	-0.498729	-0.499703	-0.499900	0.997142	0.999314
D3RDY	0.479334	-0.498715	-0.499689	-0.499886	-0.498715	-0.499689
DJ	-0.139026	-0.212681	-0.213096	-0.213180	0.424305	0.423275
DF	-0.341983	0.424905	0.425275	0.427207	-0.212681	-0.213096
DM	-0.111463	0.425227	0.425963	0.426775	-0.212681	-0.213096
DA	-.366217E-01	-0.212681	-0.213096	-0.213180	0.425227	0.425968
DMY	0.228473	-0.212681	-0.213096	-0.213180	-0.212681	-0.213096
DJN	.503956E-01	-0.212681	-0.213096	-0.213180	-0.212681	-0.213096
DJL	0.112671	-0.212681	-0.213096	-0.213180	0.425713	0.425427
DAG	0.237639	-0.212681	-0.213096	-0.213180	-0.212681	-0.213096
DST	.261550E-01	-0.212681	-0.213096	-0.213180	0.426004	0.425101
DCC	-.303440E-01	0.425313	0.425427	0.425618	-0.212681	-0.213096
DNV	-0.227406	0.426004	0.425101	0.425643	-0.212681	-0.213096
DDC	0.230960	-0.212681	-0.213096	-0.213180	-0.212681	-0.213096
	1	2	3	4	5	6

	DSLNPF	DPLNLF	DPLNSF	DPLNPF	D1AXUS	D2AXUS
LNT	-.251414E-01	0.454222	0.462397	0.465137	0.318995	-.910539E-01
DLLNLF	-0.498734	-0.497566	-0.498537	-0.498734	-0.935968	0.470277
DLLNSF	-0.499708	-0.498537	-0.499511	-0.499708	-0.941618	0.470995
DLLNPF	-0.499905	-0.498734	-0.499708	-0.499905	-0.943234	0.471181
DSLNLF	0.998194	-0.497566	-0.498537	-0.498734	0.471622	-0.931171
DSLNSF	0.999715	-0.498537	-0.499511	-0.499708	0.472543	-0.937733
DSLNPF	1.00000	-0.498734	-0.499708	-0.499905	0.472729	-0.939690
DPLNLF	-0.498734	1.00000	0.999074	0.998194	0.471622	0.470277
DPLNSF	-0.499708	0.999074	1.00000	0.999715	0.472543	0.470995
DPLNPF	-0.499905	0.998194	0.999715	1.00000	0.472729	0.471181
D1AXUS	0.472729	0.471622	0.472543	0.472729	1.00000	-0.445666
D2AXUS	-0.939690	0.470277	0.470995	0.471181	-0.445666	1.00000
D3AXUS	0.466903	-0.920993	-0.931131	-0.932011	-0.441521	-0.440475
	7	8	9	10	11	12

	DSLNPF	DPLNLF	DPLNSF	DPLNPF	D1AXUS	D2AXUS
D1AXUK	-0.415945	-0.414971	-0.415781	-0.415945	-0.395945	0.392045
D2AXUK	0.334239	-0.441874	-0.442737	-0.442912	0.410834	-0.941783
D3AXUK	-0.435642	0.845851	0.859999	0.868965	0.411959	0.410610
D1RDY	-0.498899	-0.498723	-0.499722	-0.499899	-0.947551	0.471175
D2RDY	0.999772	-0.498729	-0.499783	-0.499900	0.472725	-0.942712
D3RDY	-0.498686	0.997240	0.999272	0.999742	0.472711	0.471163
DJ	0.427707	-0.212681	-0.213096	-0.213180	0.201591	-0.376116
DF	-0.213180	-0.212681	-0.213096	-0.213180	-0.372615	0.200931
DM	-0.213180	-0.212681	-0.213096	-0.213180	-0.379950	0.200931
DA	0.426775	-0.212681	-0.213096	-0.213180	0.201591	-0.412294
DMY	-0.213180	0.424905	0.426275	0.427707	0.201591	0.200931
DJN	-0.213180	0.425227	0.425968	0.426775	0.201591	0.200931
DJL	0.425618	-0.212681	-0.213096	-0.213180	0.201591	-0.398618
DAG	-0.213180	0.425313	0.425427	0.425618	0.201591	0.200931
DST	0.425843	-0.212681	-0.213096	-0.213180	0.201591	-0.420422
DOC	-0.213180	-0.212651	-0.213096	-0.213180	-0.439249	0.200931
DNV	-0.213180	-0.212681	-0.213096	-0.213180	-0.420918	0.200931
DDC	-0.213180	0.426034	0.425131	0.425847	0.201591	0.200931
	7	8	9	10	11	12

	D3AXUS	D1AXUK	D2AXUK	D3AXUK	D1RDY	D2RDY
INT	-0.553739	-.966784E-01	0.191046	0.500308	-0.441350	-.216262E-01
DLINLF	0.465829	0.897012	-0.441874	-0.434621	0.996856	-0.498729
DLINSF	0.466719	0.920686	-0.442737	-0.435472	0.999134	-0.499723
DLINPF	0.466903	0.929220	-0.442912	-0.435642	0.999894	-0.499900
DSLNLF	0.465829	-0.414971	0.966567	-0.434621	-0.498725	0.997162
DSLNSF	0.466719	-0.415781	0.877726	-0.435472	-0.499722	0.999314
DSLNPF	0.466903	-0.415945	0.834239	-0.435642	-0.499899	0.999772
DPLNLF	-0.926993	-0.414971	-0.441874	0.845851	-0.498728	-0.498729
DPLNSF	-0.931181	-0.415781	-0.442737	0.859999	-0.499722	-0.499783
DPLNPF	-0.932011	-0.415945	-0.442912	0.868965	-0.499899	-0.499900
D1AXUS	-0.441521	-0.395945	0.410834	0.411959	-0.947551	0.472725
D2AXUS	-0.442075	0.392045	-0.941783	0.410610	0.471175	-0.942712
D3AXUS	1.00000	0.388486	0.413672	-0.855459	0.466897	0.466898
D1AXUK	0.388436	1.00000	-0.368524	-0.362475	0.336574	-0.415941
D2AXUK	0.413672	-0.368524	1.00000	-0.385975	-0.442907	0.386661
D3AXUK	-0.855459	-0.362475	-0.385975	1.00000	-0.435637	-0.435636
D1RDY	0.466897	0.336574	-0.442907	-0.435637	1.00000	-0.499895
D2RDY	0.466501	-0.415941	0.386661	-0.435639	-0.499895	1.00000
D3RDY	-0.934942	-0.415930	-0.442995	0.871445	-0.499869	-0.499881
DJ	0.199137	-0.177377	0.292312	-0.185776	-0.213175	0.433663
DF	0.199107	0.294613	-0.188876	-0.185776	0.427675	-0.213178
DM	0.199137	0.336877	-0.188876	-0.185776	0.419372	-0.213178
DA	0.199147	-0.177377	0.336436	-0.185776	-0.213178	0.420152
DMY	-0.383970	-0.177377	-0.188876	0.396451	-0.213178	-0.213178
DJN	-0.384701	-0.177377	-0.188876	0.418452	-0.213178	-0.213175
DJL	0.199137	-0.177377	0.399603	-0.185776	-0.213174	0.422533
DAG	-0.384134	-0.177377	-0.188876	0.390165	-0.213178	-0.213178
DST	0.199137	-0.177377	0.434759	-0.185776	-0.213175	0.429989
DOC	0.199137	0.353823	-0.188876	-0.185776	0.429127	-0.213178
DNV	0.199137	0.367899	-0.188876	-0.185776	0.437914	-0.213178
DDC	-0.388749	-0.177377	-0.188876	0.380164	-0.213179	-0.213178

	D3AXUS 13	D1AXUK 14	D2AXUK 15	D3AXUK 16	D1RDY 17	D2RDY 18
	D3RDY	DJ	DF	DM	DA	DMY
INT	0.470334	-0.119825	-0.241983	-0.111463	-.368217E-01	0.225473
D1LNLF	-0.492715	-0.212681	0.424925	0.425227	-0.212681	-0.212681
D1LNSF	-0.499689	-0.213096	0.425275	0.425968	-0.213096	-0.213096
D1LNPF	-0.499886	-0.213180	0.427247	0.426775	-0.213180	-0.213180
DSLNLF	-0.493715	0.424925	-0.212681	-0.212681	0.425227	-0.212681
DSLNSF	-0.499689	0.425275	-0.213096	-0.213096	0.425968	-0.213096
DSLNPF	-0.499886	0.427227	-0.213180	-0.213180	0.426775	-0.213180
DPLNLF	0.987240	-0.212681	-0.212681	-0.212681	-0.212681	0.424905
DPLNSF	0.989272	-0.213096	-0.213096	-0.213096	-0.213096	0.428275
DPLNPF	0.989742	-0.213180	-0.213180	-0.213180	-0.213180	0.427227
D1AXUS	0.472711	0.201591	-0.372615	-0.379950	0.201591	0.201591
D2AXUS	0.471107	-0.376116	0.200931	0.200931	-0.412794	0.200931
D3AXUS	-0.934942	0.199127	0.199127	0.199127	0.199127	-0.363978
D1AXUK	-0.415930	-0.177377	0.294613	0.336877	-0.177377	-0.177377
D2AXUK	-0.442895	0.292312	-0.188876	-0.188876	0.386436	-0.188876
D3AXUK	0.877448	-0.185776	-0.185776	-0.185776	-0.185776	0.376451
D1RDY	-0.499880	-0.213178	0.423675	0.419332	-0.213178	-0.213178
D2RDY	-0.499881	0.433663	-0.213179	-0.213178	0.420152	-0.213178
D3RDY	1.00000	-0.213172	-0.213172	-0.213172	-0.213172	0.424629
DJ	-0.213172	1.00000	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DF	-0.213172	-.909091E-01	1.00000	-.909091E-01	-.909091E-01	-.909091E-01
DM	-0.213172	-.909091E-01	-.909091E-01	1.00000	-.909091E-01	-.909091E-01
DA	-0.213172	-.909091E-01	-.909091E-01	-.909091E-01	1.00000	-.909091E-01
DMY	0.120886	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	1.00000
DJN	0.428743	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DJL	-0.213172	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DAG	0.424631	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DST	-0.213172	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DOC	-0.213172	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DNV	-0.213172	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DDC	0.439120	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01

	19	20	21	22	23	24
	DJN	DJL	DAG	DST	DOC	DNV
INT	.508958E-01	0.112671	0.237389	.261550E-01	-.803440E-01	-0.227496
D1LNLF	-0.212681	-0.212681	-0.212681	-0.212681	0.425313	0.426004
D1LNSF	-0.213096	-0.213096	-0.213096	-0.213096	0.425427	0.425101
D1LNPF	-0.213180	-0.213180	-0.213180	-0.213180	0.425618	0.425843
DSLNLF	-0.212681	0.425313	-0.212681	0.426004	-0.212681	-0.212681
DSLNSF	-0.213096	0.425427	-0.213096	0.425101	-0.213096	-0.213096
DSLNPF	-0.213180	0.425618	-0.213180	0.425843	-0.213180	-0.213180
DPLNLF	-0.425227	-0.212681	0.425313	-0.212681	-0.212681	-0.212681
DPLNSF	0.425968	-0.213096	0.425427	-0.213096	-0.213096	-0.213096
DPLNPF	0.426775	-0.213180	0.425618	-0.213180	-0.213180	-0.213180
D1AXUS	0.201591	0.201591	0.201591	0.201591	-0.439749	-0.422918
D2AXUS	0.200931	-0.398613	0.200931	-0.420422	0.200931	0.200931

	DJN	DJL	DAG	DST	DOC	DNV
D3AXUS	-0.364701	0.199107	-0.384134	0.199107	0.199127	0.199107
D1AXUY	-0.177377	-0.177377	-0.177377	-0.177377	0.393923	0.393599
D2AXUY	-0.138876	0.389603	-0.138876	0.434750	-0.138876	-0.138876
D3AXUY	0.413052	-0.185776	0.396555	-0.185776	-0.185776	-0.185776
D1RDY	-0.213178	-0.213178	-0.213178	-0.213178	0.429123	0.433294
D2RDY	-0.213178	0.422533	-0.213178	0.426787	-0.213178	-0.213178
D3RDY	0.420793	-0.213172	0.424632	-0.213172	-0.213172	-0.213172
DJ	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DF	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DM	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DA	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DMY	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DJN	1.00000	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DJL	-.909091E-01	1.00000	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
DAG	-.909091E-01	-.909091E-01	1.00000	-.909091E-01	-.909091E-01	-.909091E-01
DST	-.909091E-01	-.909091E-01	-.909091E-01	1.00000	-.909091E-01	-.909091E-01
DOC	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	1.00000	-.909091E-01
DNV	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	1.00000
DIC	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01	-.909091E-01
	25	26	27	28	29	30

	DIC
INT	0.280960
DLLNLF	-0.212681
DLLNSF	-0.213096
DLLNPF	-0.213148
DSLNLF	-0.212681
DSLNSF	-0.213096
DSLNPF	-0.213148
DPLNLF	0.426274
DPLNSF	0.425101
DPLNPF	0.425243
D1AXUS	0.201591
D2AXUS	0.200931
D3AXUS	-0.459999
D1AXUY	-0.177377
D2AXUY	-0.138876
D3AXUY	0.320150
D1RDY	-0.213178
D2RDY	-0.213178
D3RDY	0.439127
DJ	-.909091E-01
DF	-.909091E-01
DM	-.909091E-01
DA	-.909091E-01
DMY	-.909091E-01
DJN	-.909091E-01
DJL	-.909091E-01
DAG	-.909091E-01
DST	-.909091E-01
DOC	-.909091E-01
DNV	-.909091E-01

APPENDIX H.

CALCULATION OF EXPENDITURE SHARES

1) From the 1975 Household Expenditure survey, Taplin estimated that the proportion of overseas travel expenditure to the total expenditure was 1.114%.

   a) total number of overseas travellers from 1972 to 1980 was 10,973,629.

      - total number of Australian travellers travelling to the U.S. was 737,474 for the same period.
      - if average expenditure is assumed to be the same in the U.S. as elsewhere, the share of travellers travelling to the U.S. was 20.16%.

   b) 20.16% of 1.114% expenditure share is 0.0749%.

2) The expenditure in each travel period is approximately by: the fare multiplied by the number of leisure travellers in each season.

Expenditure Share in Each Travel Season

Season	Revenue ($)	% Share
Low	14,431,486.09	21.13%
Shoulder	19,997,161.37	29.28%
Peak	33,865,459.81	49.59%
Total	68,294,107.27	100%

3) The share of total expenditure on U.S. travel by seasons

		% Share
Low season	= 0.002246 x 0.2113 = 0.000475	0.0475
Shoulder season	= 0.002246 x 0.2928 = 0.000658	0.0658
Peak season	= 0.002246 x 0.4959 = 0.001114	0.11138

APPENDIX H.1.

CALCULATION OF CROSS PRICE ELASTICITY WITH RESPECT TO OTHER GOODS AND SERVICES FROM TABLE 7.2

The Cournot Column Aggregation was used to calculate the cross price elasticity with respect to other goods and services.

1) for column j the cross elasticity of demand for other goods and services with respect to the price of j using the Cournot Aggregation:

$$R_1E_{1j} + R_2E_{2j} + R_3E_{3j} + R_4R_{4j} = - R_j$$

where R_1 ..., R_j are shares of total expenditure (R_4 is the proportion of all other expenditures in the total) and E_{1j} (1, ...4) is the cross elasticity of demand for i with respect to the price of j.

2) The cross elasticity of demand for j with respect to the prices of all other goods and services is:

$$E_{i6} = \frac{R_6}{R_i} E_{6i} + R_6 (E_{6y} - E_{iy})$$

E_{6y} is the income elasticity of demand for all other goods and services which is 0.9978 (obtained by applying the Engel Aggregation: weighted sum of income elasticities is unity).

As R_6 is 99.78, the full term is used.

For shoulder period:

$$(0.4 \times 0.0475) + (-0.96 \times 0.0658) + (0.58 \times 0.11138) = 0.0204$$

$$\frac{-0.0204 - 0.0658}{99.78} = -0.00086$$

- the cross elasticity of demand for travel in the shoulder season with respect to price of other consumer goods and services is:

$$(\frac{99.78}{0.0658}) - 0.00086 + 0.9978 (0.9978 - 1) = -1.31.$$

APPENDIX H.2

ADJUSTMENT OF THE OWN PRICE ELASTICITY USING THE COURNOT CONDITION.

The procedure is similar to that shown for Appendix H. In this case, it was assumed that the cross price elasticities of demand with respect to other consumer goods and services approximate zero. Thus, through a series of iteration, the following own price elasticities were estimated.

1) Calculation of $E_{11} = -2.2$

$$(-2.2 \times 0.0475) + (0.31 \times 0.0658) + (0.33 \times 0.11138) = -0.048$$

$$\frac{0.048 - 0.0475}{99.78} = 0.000005$$

$$\left(\frac{99.78}{0.0475}\right) 0.000008 + 0.9978\ (0.9978 - 1) = 0.01$$

2) Calculation of $E_{22} = -2.3$

$$(0.4 \times 0.0475) + (-2.3 \times 0.0658) + (0.58 \times 0.11138) + R_4E_{7j} = -R_j$$

$$-0.0677 + R_4E_{7j} = -R_j$$

$$R_4E_{7j} = 0.0677 - 0.0658$$

$$E_{7j} = \frac{0.0019}{99.78}$$

$$E_{7j} = 0.000019$$

By symmetry: $E_{27} = \dfrac{99.78}{0.0658}\ 0.000019 + 0.9978\ (0.9978 - 1)$

$$= 0.0267 + (-0.0022) = 0.03$$

3) Calculation of $E_{33} = -2.0$

$$(-2.0 \times 0.11138) + (0.77 \times 0.0475) + (0.99 \times 0.0658) = -0.121$$

$$\frac{0.121 - 0.11138}{99.78} = 0.000096$$

$$\frac{99.78}{0.11138}\ 0.000098 + 0.9978\ (0.9978 - 1) = 0.08$$

It should be noted that there may be some rounding errors in this calculation.

APPENDIX J.

CALCULATION OF OPTIMUM FARES

Optimum fares at 80% of the number of peak travellers

$$\begin{bmatrix} \ln(8436) - 13.7553 \\ \ln(8436) - 14.4487 \\ \ln(8436) - 16.3208 \end{bmatrix} = \begin{bmatrix} -4.7151 \\ -5.4084 \\ -7.2805 \end{bmatrix}$$

$$\begin{bmatrix} -0.517 & -0.1605 & -0.279 \\ -0.1193 & -0.5367 & -0.3101 \\ -0.1201 & -0.1813 & -0.636 \end{bmatrix} \begin{bmatrix} -4.7151 \\ -5.4084 \\ -7.2805 \end{bmatrix} = \begin{array}{ll} \begin{bmatrix} 207.89 \\ 304.13 \\ 481.65 \end{bmatrix} & \begin{array}{l} \text{low} \\ \text{shoulder} \\ \text{peak} \end{array} \end{array}$$

APPENDIX K.

CALCULATION OF THE INDIVIDUAL EFFECTS OF THE OPTIMUM FARES IN EACH TRAVEL SEASON.

An arc elasticity approximation was used to calculate the individual effects of the fare changes. For example, to calculate the change in patronage due to a 13.1% decrease in the real low fare:

(a) [(% change) x elasticity] x present loading = X_1

[(% change) x elasticity] x desired loading = X_2

(b) $\frac{\Sigma X_i}{2} = X =$ the independent effect of a 13.1% decrease in the low fare.

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